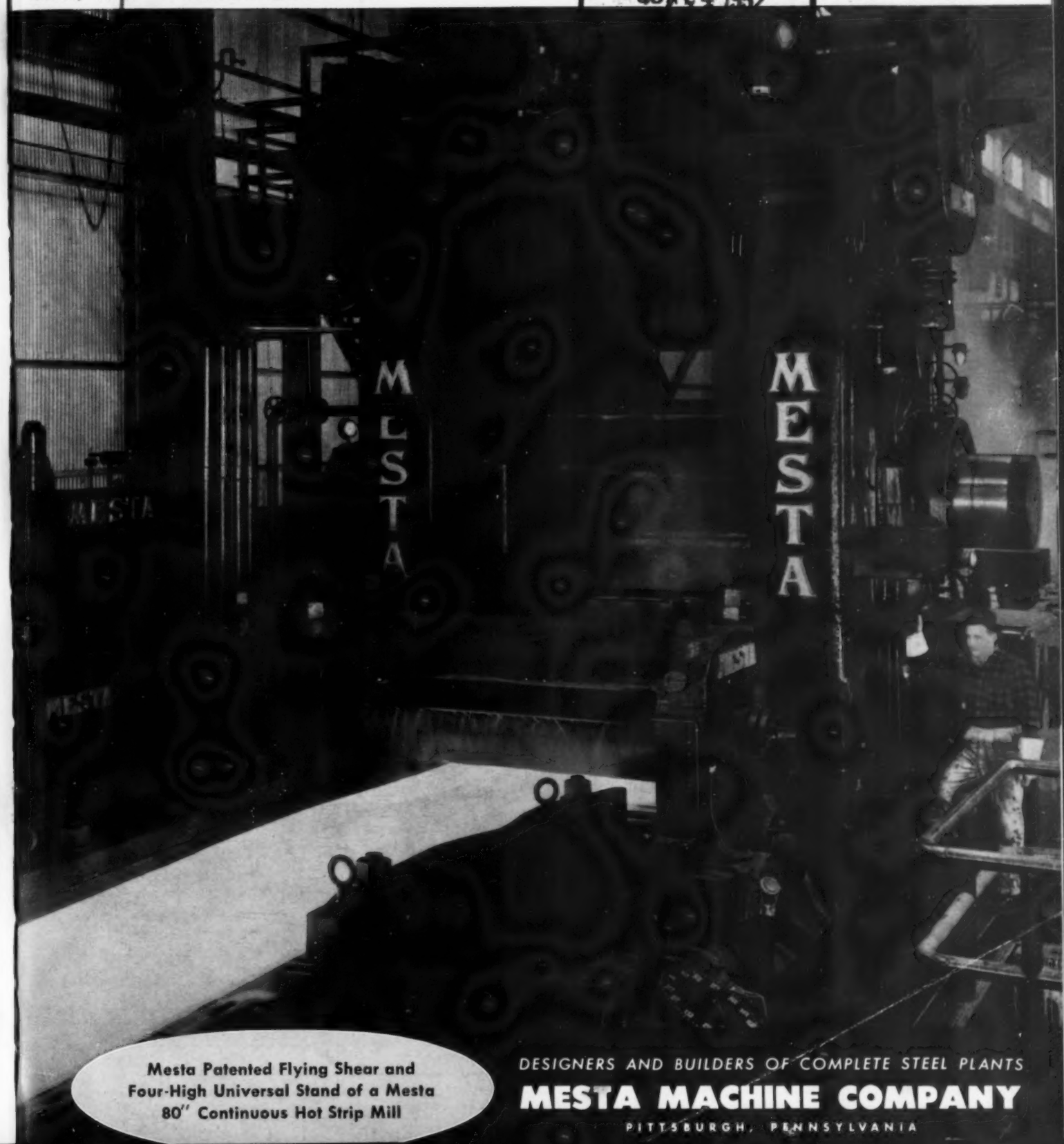
Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

JUNE, 1952

TECHNOLOGY DEPT.

JUN 24 1952
TABLE OF CONTENTS, Page 53

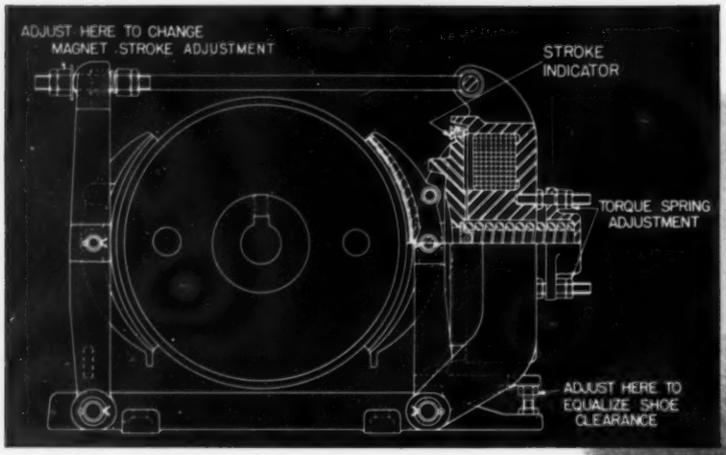


Mesta Patented Flying Shear and Four-High Universal Stand of a Mesta 80" Continuous Hot Strip Mill

DESIGNERS AND BUILDERS OF COMPLETE STEEL PLANTS

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA


ADJUST HERE TO CHANGE MAGNET STROKE ADJUSTMENT
STROKE INDICATOR
TORQUE SPRING ADJUSTMENT
ADJUST HERE TO EQUALIZE SHOE CLEARANCE

What better Proof?

All attempts to duplicate the performance of the Cutler-Hammer Type M Mill Brake lead to the use of a short stroke direct acting magnet

In the light of the experience of many years, it must be said that when Cutler-Hammer Engineers designed the Type M Mill Duty Brake, they brought out the most nearly ideal solution to the problem of braking action. For any attempts made since then to duplicate its performance lead closer and closer to a duplication of its principle of operation (i.e. short stroke magnet . . . straight line action). Analysis shows that the Type M Brake embodies the simplest and most direct means of achieving braking action. Its structure is very simple and understandable. It employs the fewest parts in its construction. Though sturdy and rugged, it is compact. Braking action is smooth, fast, positive. Linings wear slowly. Only three adjustments are required and are simply made. The Type M Brake is dependable and trouble-free. You can learn more about the design, construction and performance of this brake by writing for Publication BR-2. . . . CUTLER-HAMMER, Inc., 1255 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

14 Facts about Type M Brake

- ✓ Fundamental design proved by years of service in heavy duty applications
- ✓ The simplest of all brakes
- ✓ Has the fewest parts
- ✓ The brake with the fastest action
- ✓ The only brake with one-to-one magnet and total shoe stroke
- ✓ The brake with only 3 simple adjustments
- ✓ Longest service without take-up adjustments
- ✓ Tough long-life lining matched with hard Hammerloy steel wheel
- ✓ Cover-all tubes shield full length of hinge pins against paint, dirt, etc.
- ✓ Renewable hardened hinge pin bushings
- ✓ Hard sheet aluminum magnet coil cover plate caulked in place with aluminum wire
- ✓ Torque spring compression CANNOT be released manually
- ✓ Torque spring fully protected
- ✓ Brass friction plugs keep shoes always aligned

All of these features are also provided, when used on A.C. Service with rectifier

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MOTOR CONTROL
C-H

It Set the Pattern Years Ago
It has Set the Pace Ever Since

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 29, No. 6.

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THE AETNA-STANDARD ENGINEERING COMPANY • PITTSBURGH, PA.

Plants in Warren, Ohio · Ellwood City, Pennsylvania

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Let a Texaco Lubrication Engineer help you keep all your machinery at top efficiency. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

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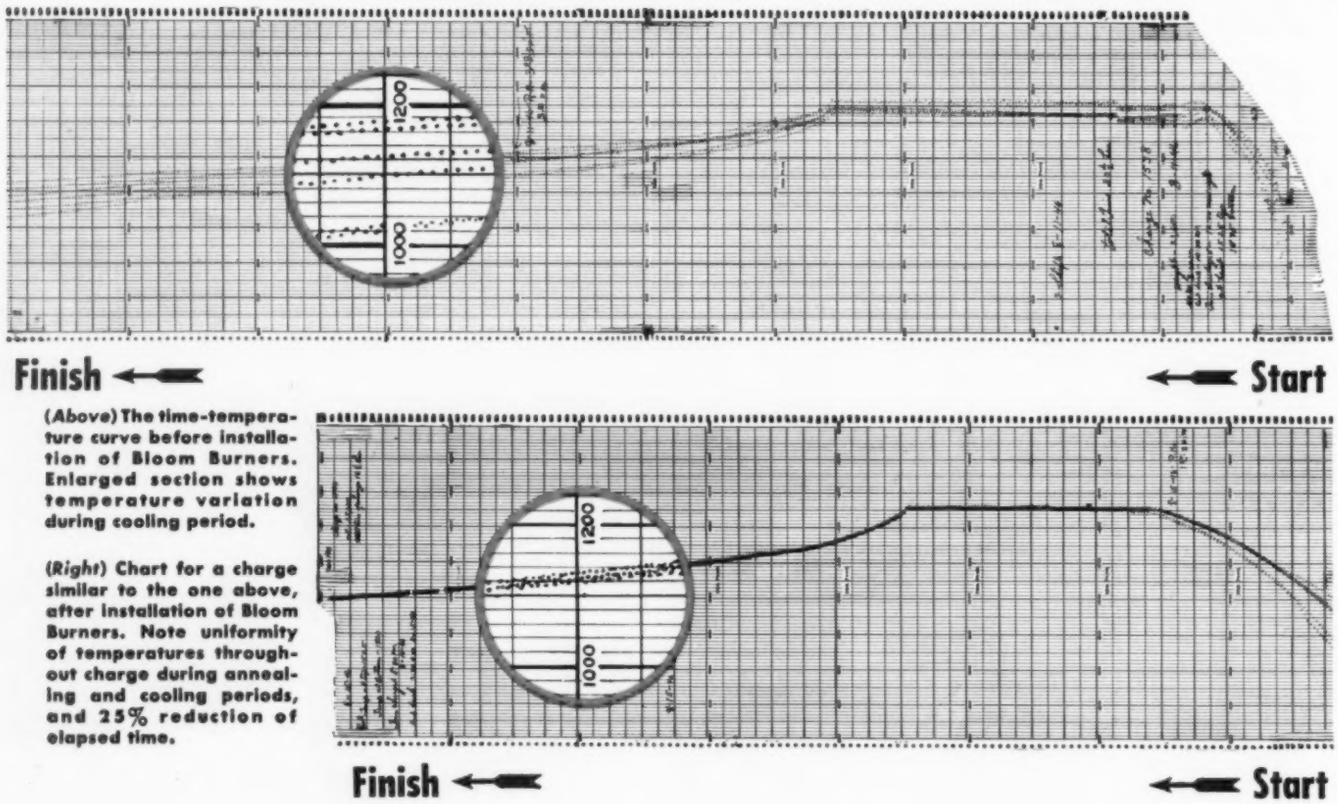
Faithfully yours 50 *for Fifty Years*

TUNE IN . . . TEXACO STAR THEATER starring MILTON BERLE on television every Tuesday night. See newspaper for time and station.

Uniform Temperatures and Faster Heating WITH BLOOM



(*Above*) The time-temperature curve before installation of Bloom Burners. Enlarged section shows temperature variation during cooling period.

(*Right*) Chart for a charge similar to the one above, after installation of Bloom Burners. Note uniformity of temperatures throughout charge during annealing and cooling periods, and 25% reduction of elapsed time.

The time-temperature curves above show how Bloom Tempered Flame Burners maintain uniform temperatures throughout the charge, and improve furnace operation and output. They represent two similar annealing heats for a car-type annealing furnace, one before and the other after Bloom Burners were installed.

The upper curve shows a test run previous to the change-over. Variation throughout the charge at the annealing temperature was from 1440 to 1540 degrees F., and at finish, it ranged from 840 to 1040 degrees F.

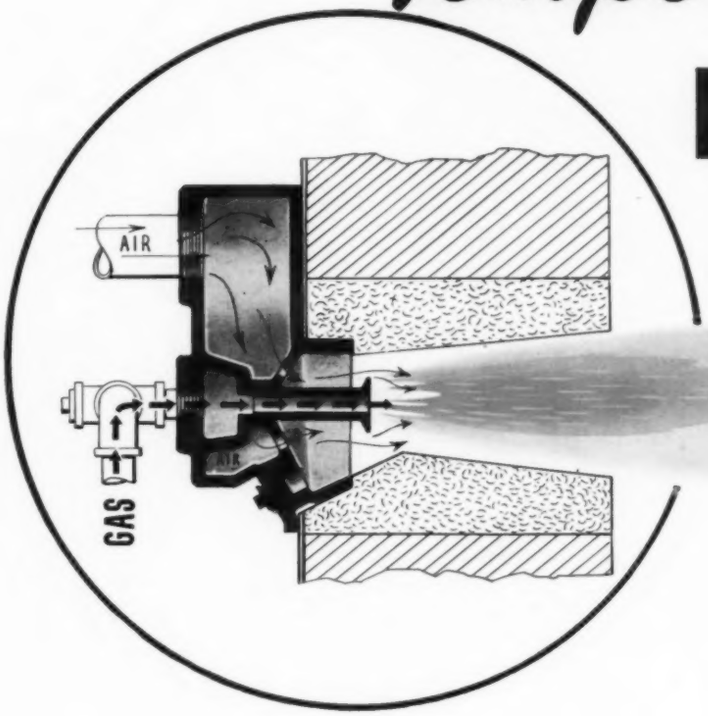
After installing Bloom Burners, the temperatures were held to within plus or minus 10 degrees F. for a similar charge, and the elapsed time was reduced 25 per cent.

The unique design of Bloom Tempered Flame Burners permits operation with a high per-

ENGINEERED

Tempered Flame

BURNERS

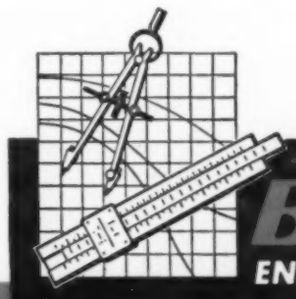


The Bloom Tempered Flame Burner is available in a wide range of capacities. The cross-section view above shows a typical burner.

centage of excess air. The burners operate with flame temperature only slightly higher than that required by the charge. Consequently hot and cold spots within the furnace chamber are eliminated, and the charge is heated uniformly. Five years of experience in a variety of applications have demonstrated the ability of these burners to increase furnace production, reduce costs and improve quality of product.

Write

for bulletin 1220-5, which describes Bloom Tempered Flame Burners. It gives dimensions and capacities for the various types.



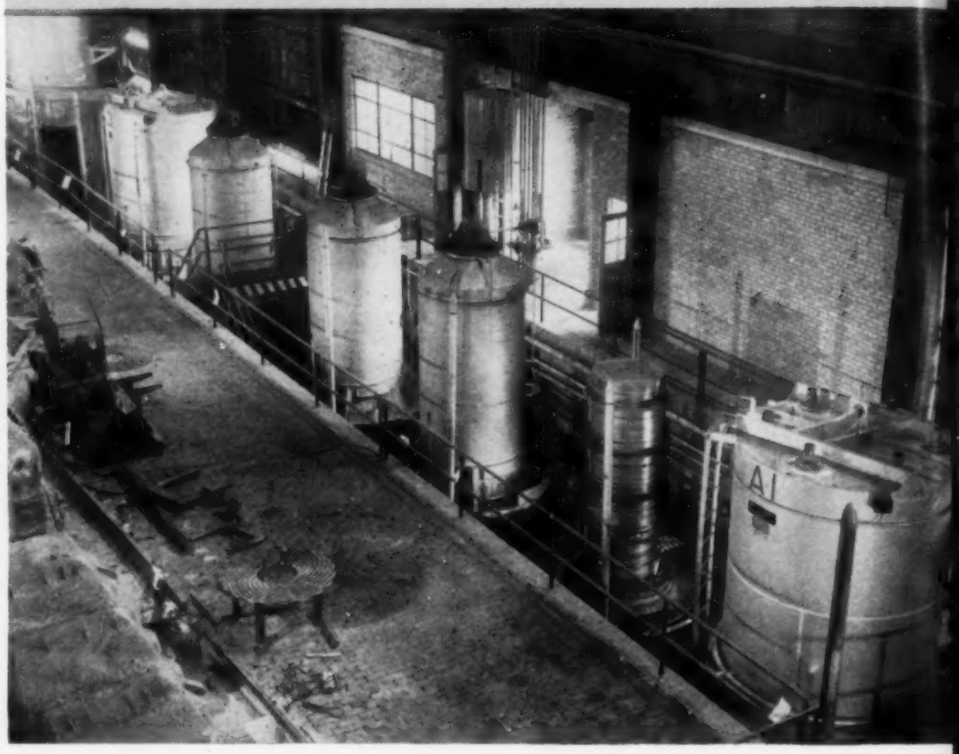
BLOOM
ENGINEERING CO., INC.
857 W. North Avenue Pittsburgh 33, Pa.

WILSON Single stack, portable base convection annealing furnaces

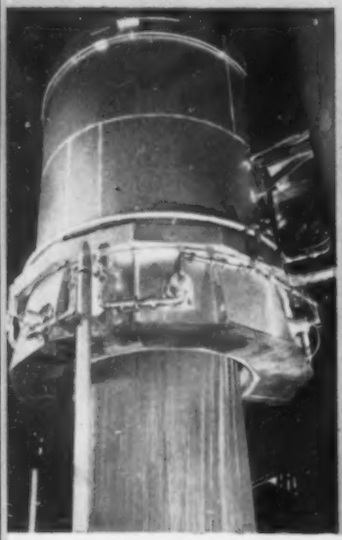
WILSON Single Stack, Portable Base Annealing Furnaces have many advantages, a few of which are shown in the pictures below.

Other advantages are the use of light cranes, faster turnover, higher heat input per stack, and production doubled as compared to multiple-stack furnaces.

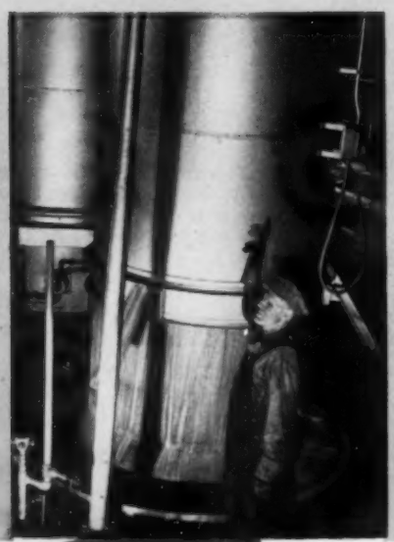
TYPICAL INSTALLATION OF SINGLE STACK FURNACES



QUICK HANDLING



LOW LABOR COST



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This "sandwich" protects the varnish cambric. It enables A.V.C. to carry more current than cables with conventional insulations.
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Varnished Cambric
Outer Felted Asbestos Wall

FOR KEEPING COSTS DOWN!

Steel Mill and Foundry "hot spots" provide one of the world's worst torture chambers for wire and cable. Heat, steam and corrosive fumes combine to kill *ordinary* cable quickly.

To keep costs down and current dependably flowing, use Rockbestos A.V.C. Cable in all circuits . . . especially "hot spots."

Permanently insulated Rockbestos A.V.C. takes temperatures up to 230°F. Even severe heat or flame won't crack, blister or burn it.

What's more, Rockbestos A.V.C. won't bloom or rot when exposed to oil, grease or corrosive fumes.

Built to beat the heat, Rockbestos A.V.C. reduces maintenance and operating costs . . . gives you years more dependable service. Plan now to avoid future "hot spot" failures and expense — install Rockbestos A.V.C.

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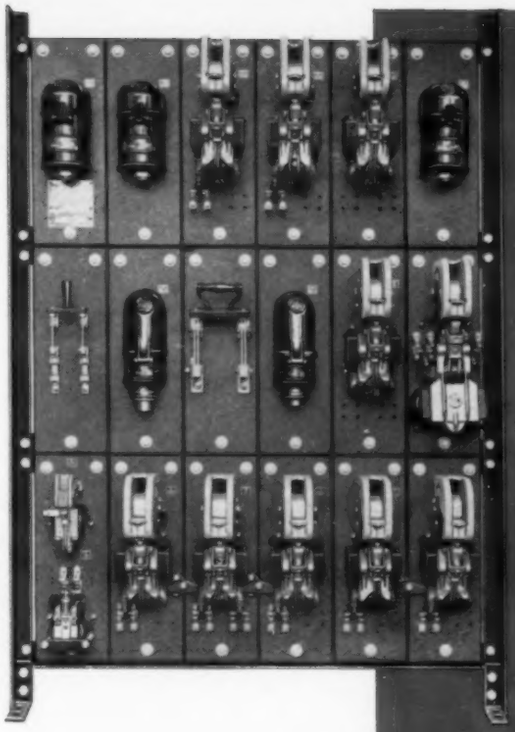


LOOK for these NAMES when buying Motor Control

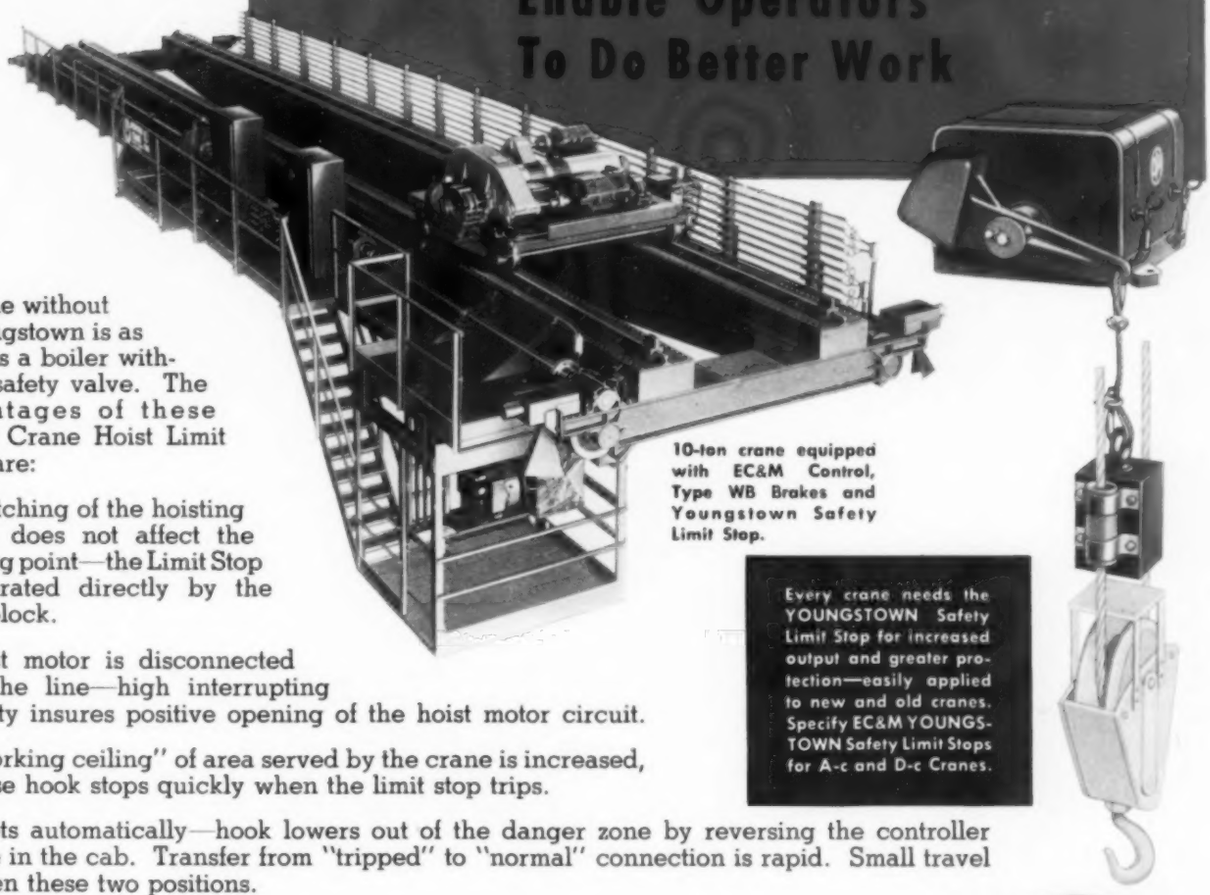
1 LINE-ARC Contactors
2 TIME-CURRENT Acceleration (D-c)
3 FREQUENCY RELAY Acceleration (A-c)
4 WRIGHT CIRCUIT Hoist Control (D-c)
5 YOUNGSTOWN Hoist Limit Stops
6 TYPE WB Brakes
7 CAM Master Switches
8 MANUAL-MAGNETIC Disconnect Switches
9 CONTRA-TOROUE Hoist Control (A-c)
10 TAB-WELD Resistors

These FUNCTIONAL NAMES Speak for Themselves

YOUNGSTOWN *Safety* LIMIT STOPS for Crane Hoists

Eliminate *OVERHOISTING* Fear

Enable Operators To Do Better Work



10-ton crane equipped with EC&M Control, Type WB Brakes and Youngstown Safety Limit Stop.

A crane without a Youngstown is as risky as a boiler without a safety valve. The advantages of these EC&M Crane Hoist Limit Stops are:

1 Stretching of the hoisting cables does not affect the tripping point—the Limit Stop is operated directly by the hook block.

2 Hoist motor is disconnected from the line—high interrupting capacity insures positive opening of the hoist motor circuit.

3 "Working ceiling" of area served by the crane is increased, because hook stops quickly when the limit stop trips.

4 Resets automatically—hook lowers out of the danger zone by reversing the controller handle in the cab. Transfer from "tripped" to "normal" connection is rapid. Small travel between these two positions.

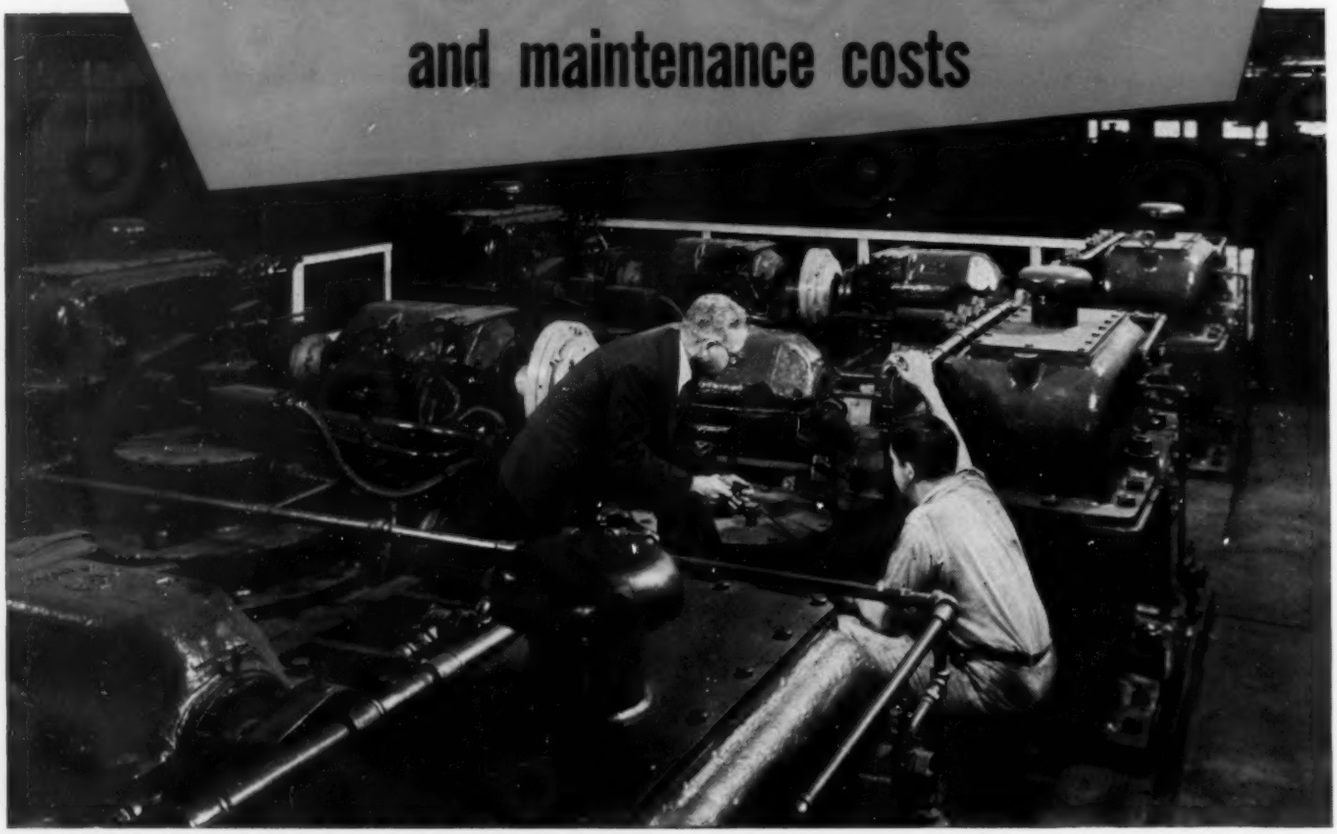
5 Compact, easy to mount—only a single suspended weight.

Every crane needs the YOUNGSTOWN Safety Limit Stop for increased output and greater protection—easily applied to new and old cranes. Specify EC&M YOUNGSTOWN Safety Limit Stops for A-c and D-c Cranes.

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

NUMBER 1 OF A SERIES

How Gulf Periodic Consultation Service helps rolling mills cut lubrication and maintenance costs



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They survey equipment, make practical lubricant recommendations; provide simplified lubrication charts; and suggest better application methods. They also provide expert help on special problems that involve lubricants or lubrication.

They know and completely understand the effect of different operating conditions on lubricants and, just as important, the lubrication requirements of all types of textile mill equipment. And available to them are the facilities of one of the finest petroleum laboratories in the world.

For additional information, call in a Gulf Lubrication Engineer today or send the coupon below.

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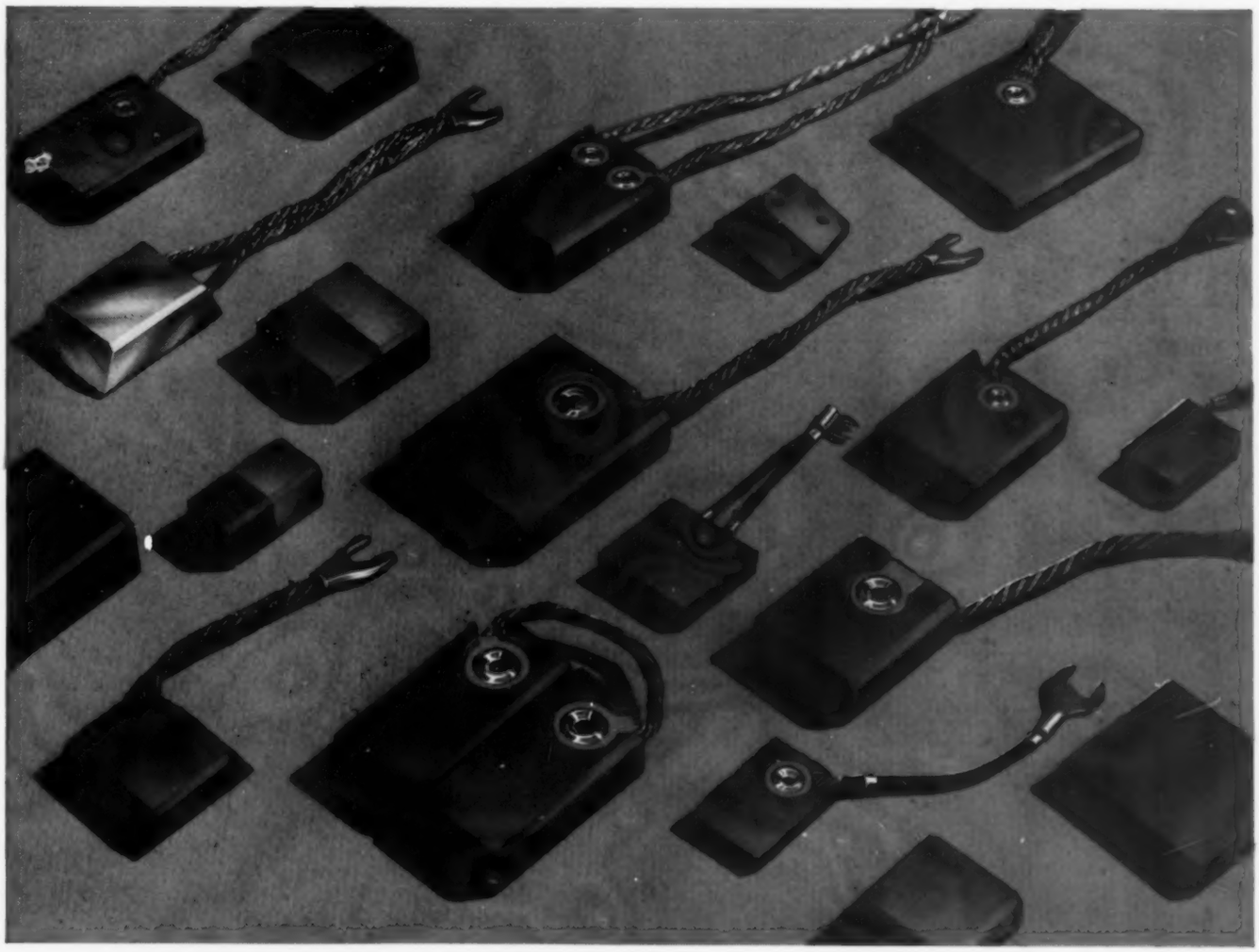
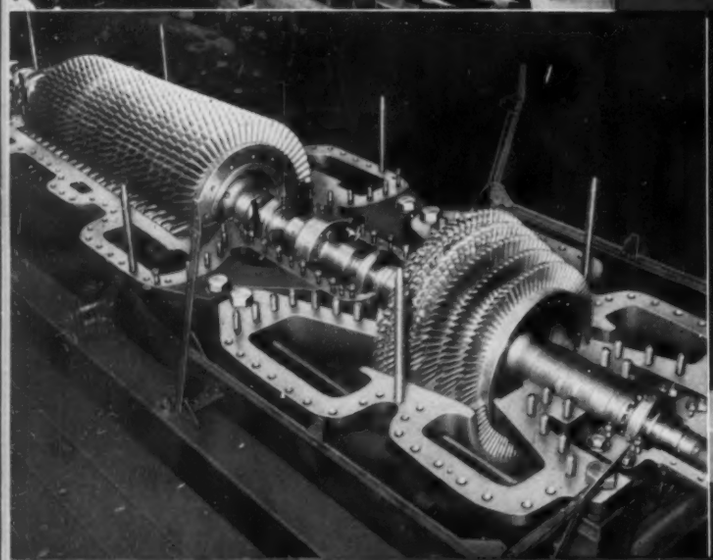


90-B

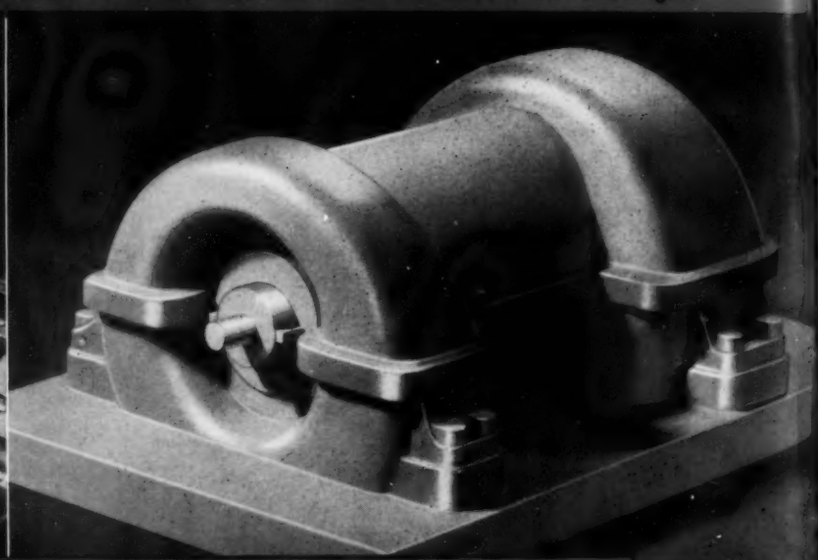
THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

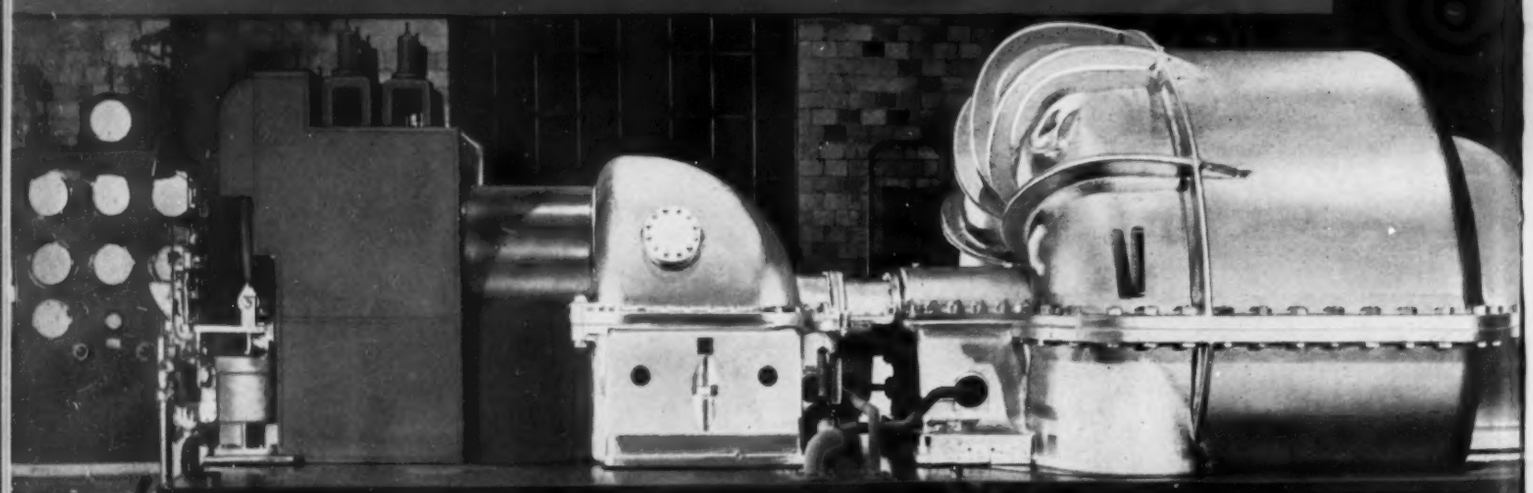
This Allis-Chalmers 120,000 cfm axial compressor drives the world's fastest wind tunnel, located at NACA Langley Aeronautical laboratories, Hampton, Va. The seven stage, 55-ton rotor is so perfectly balanced and friction-free that a man can move it with one finger.



Construction view of 40,000 cfm, 45 psig axial compressor used in petroleum refining. Over 30 of these units, ranging from 16,000 to 60,000 cfm, have been built by Allis-Chalmers over the past 15 years.



Scale model of axial compressor as designed for blast furnace service at 110,000 cfm, 30 psig. The axial compressor is ideally suited for the production of large air volumes at pressures up to 40 lbs. psig.



Allis-Chalmers has wide experience in designing and building air moving equipment for all industries. Shown here is an A-C 75,000 cfm, 30 psig blast furnace blower at a midwestern steel mill. This is of the centrifugal type, driven by A-C 8500 hp steam turbines.

ALLIS-

Job Moving Air

...Quantity No Object!

ALLIS-CHALMERS OFFERS AXIAL COMPRESSORS FOR BLAST FURNACE BLOWING

THE TREND TO HIGH TOP PRESSURE and larger air volumes in blast furnace blowing finds the efficient and field-proven axial compressor ready and able to supply the largest projected blast furnace or combinations of furnaces!

Allis-Chalmers — builders of both axial and centrifugal compressors — is now offering axial compressors for blast furnace service at volumes over 100,000 cfm, and at pressures of 30 psig and higher. With comparable first cost, steam savings on the order of 15 percent are possible because of axial "straight-through" air flow and higher speed operation.

An axial compressor of 110,000 cfm, 30 psig in routine blast furnace service would require 72,100 lb of steam per hr at 600 psig, 825 F, as compared to 85,-800 to drive a like centrifugal unit. Installation space and foundation costs are also reduced, since the higher rotative speed makes the axial unit shorter, more compact and lighter.

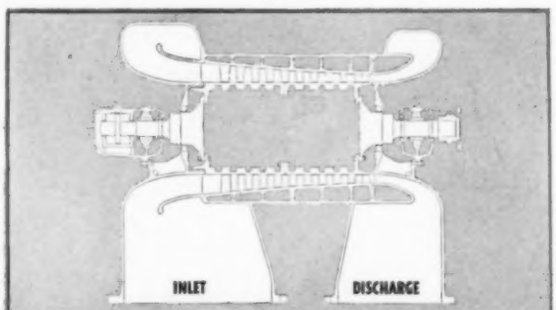
As air volumes increase, the axial compressor rapidly becomes the only practicable method. The air volumes required for even the largest foreseeable blast furnace application present no new design problems for an axial compressor. And wear-resistant alloy, precision cast blades are ideal for contaminated atmospheres.

One Allis-Chalmers axial (see upper left) has operated for four years at an output of 870,000 cfm! A-C axial design and construction have been well proven in the past 15 years with nearly *four million* cfm in capacity already in use or under construction for the petroleum, aircraft, railroad, and gas utility industries.

Blast furnaces can have their progress to more efficient size and pressures *aided* by adopting the more efficient axial compressor. Get the *full* story on how an Allis-Chalmers axial can best solve your need for large air volumes.

There is a qualified steel mill representative near you, ready to explain the axial compressor in detail. Just call the nearest A-C sales office or write for literature to Allis-Chalmers, Milwaukee 1, Wisconsin.

A-3661

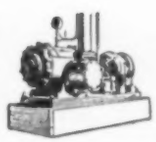


Cross section drawing of axial compressor suitable for high top pressure or other large volume blast furnace blowing. Efficient "straight-through" air flow accomplishes velocity-pressure conversion in an axial direction between alternate rows of rotor and starter blades.

SINGLE STAGE BLOWERS available in pressure ranges from one to 6.50 lb. Rigid, long-lived cast casing can be arranged to any one of 24 discharge positions.

ROTARY COMPRESSORS, sliding vane type. Capacities for 5 to 35 psig. Air is compressed in cells formed by blades moving freely in and out of longitudinal slots in rotor.

DRY VACUUM PUMPS. Range to 28½ inches hg vacuum. Same principle as rotary compressors except that action is reversed—inlet evacuates, exhaust is open.



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A-C ALLIS-CHALMERS

Power, Electrical, Processing Equipment for Iron and Steel

New Accuracy and Versatility

ALL these functions in one instrument

- indicates
- records
- controls
- integrates
- resets control index from remote signal
- retransmits to remote indicator

for all flow applications...

THE

ElectroniK

FLOW METER

HERE'S a flow meter that can perform half a dozen jobs at once. It indicates, records, controls, integrates, retransmits for remote measurement, and resets a remote index of any controller to which it is interlocked. It saves panel space, because it packs all these functions into one compact instrument case. Because of this versatility, it's the ideal choice for fuel flow control . . . either as part of an integrated fuel-air ratio and temperature control system, or as an individual fuel flow controller.

This new addition to the *ElectroniK* family of instruments brings you the full performance of the *ElectroniK* continuous-balance system, now applied to flow measurement. Like the numerous other *ElectroniK* instruments used for thousands of temperature applications, it measures electrically, by means of a powerful, sensitive motor-driven servo system. Because the primary sensing element doesn't have to do any work, measurements are made at unimpaired speed and responsiveness. And the controlled power available from the balancing system makes both measurement and control more positive . . . permits operation of additional devices such as pneumatic transmitters with no sacrifice of instrument sensitivity. Not only can the *ElectroniK* Flow Meter do many jobs —but it does each one outstandingly well because it has ample power at its command.

Where fuel consumption is required, a built-in electronic integrator aids cost accounting by accurately totalizing oil or gas flow on a six-digit counter easily read on the front of the instrument. Available with fixed or adjustable *Indexet* mechanism for setting the control index from a remote transmitter.

The *ElectroniK* Flow Meter utilizes fast, accurate electrical transmission from its remote meter body . . . can be supplied with any Brown flow transmitter; linear, square root or area type.

Your local Honeywell engineering representative will be glad to discuss how your plant can utilize the performance of this new instrument. Call him today . . . he is as near as your phone.

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First in Controls

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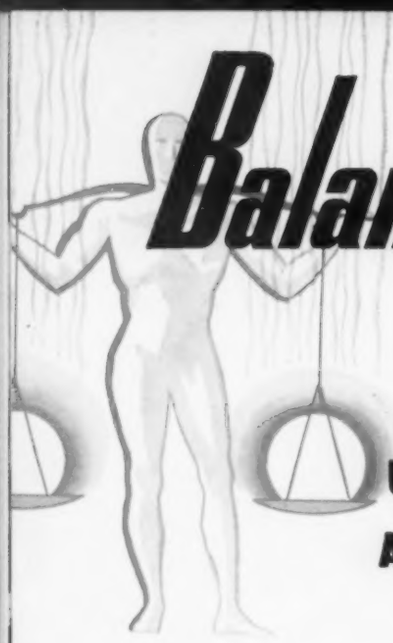
Balanced Heat Flow IN 'SURFACE' CO



VOLUME PRODUCTION AND CLOSELY CONTROLLED ANNEALING, UNHEARD OF IN PAST EMERGENCIES, ARE POSSIBLE FOR TODAY'S DEFENSE AND CIVILIAN REQUIREMENTS.

Four 'Surface' developments, used together in a balanced heat transfer system, *are breaking records for top speed and true quality in annealing.*

'Surface' harnesses heat for the steel industry. Hundreds of 'Surface' annealing covers and bases in America's leading steel mills employ the components shown below to produce thousands of tons of bright-annealed flat rolled steel each hour. They are operating in every important steel mill center from coast to coast.

Shown here is a battery of 'Surface' radiant tube coil annealing covers of the rectangular double-row type utilizing a protective controlled atmosphere for bright annealing rolled steel sheets.

1 **COIL SEPARATOR** ● Simple, rugged construction balances convection heating and cooling. Directs rapidly circulated heating and cooling gases to ends of coil laminations. This utilizes solid metal heat transfer, rather than conduction through laminations.

2 **HIGH POWERED BASE FAN** ● Power input is many times greater than used formerly. Incorporates a unique 'Surface' designed method of sealing annealing atmospheres against differential pressures.

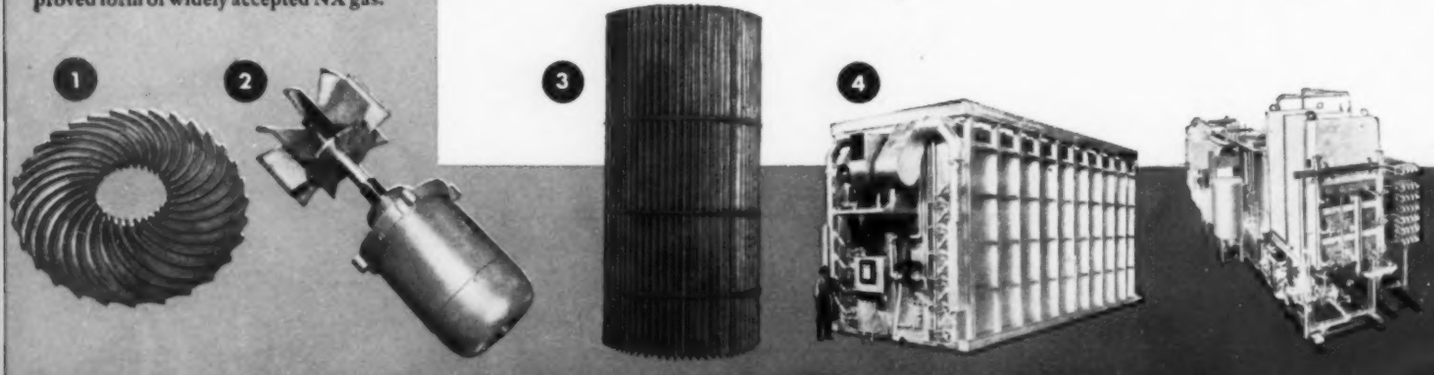
3 **CORRUGATED INNER COVER** ● Deep corrugations absorb and transfer heat to circulated gases within the inner cover during heating cycle and speed cooling of the charge by reasons of the large area exposed.

4 **RADIANT TUBE HEATING COVER** ● Stepped-up, useful heat input of 'Surface' radiant tubes balances the fast heat absorption rate of the new deep-corrugated inner covers and fast heat transfer of base fans and coil separators.

Here's an additional 'Surface' development that assures "Quality Control" of heat treated products.

HNX ANNEALING ATMOSPHERE GENERATOR ● Non-explosive HNX gas provides complete surface protection for steel in 'Surface' cover-type annealing furnaces. HNX is an improved form of widely accepted NX gas.

Submit your heating and heat treat problems to 'Surface' engineers for heat-engineered recommendations and latest equipment.



COVERS...RESULTS IN FASTER AND BETTER ANNEALING

SURFACE COMBUSTION CORPORATION • TOLEDO 1, OHIO

FOREIGN AFFILIATE COMPANIES

BRITISH FURNACES LIMITED—CHESTERFIELD
STEIN & ATKINSON, LTD.—LONDON

STEIN & ROUBAIX—PARIS, LIEGE AND GENOA
WILL L. SMITH, S.A.—BUENOS AIRES

'Surface' SERVES THE STEEL INDUSTRY

One-Way Fired Soaking Pits • Billet Reheating Furnaces • Slab Heating Furnaces • Continuous Type, Controlled Atmosphere Strip Annealing and Normalizing Furnaces • Controlled Atmosphere Annealing Covers for Wire and Rod • Controlled Atmosphere Annealing Covers for Coil and Sheets • Continuous Furnaces for Heat Treatment of Steel Plate • Controlled Atmosphere Furnaces for Carbon Correction in High Alloy Rod and Bar Stock • Continuous Type Bright Annealing and Normalizing Furnaces • Prepared Gas Atmosphere Generating Equipment • Pit Type Convection Furnaces for Rod Annealing • Stress Relief Furnaces • Wire Patenting Furnaces

New *Life-Line* Safety Switch

Stands up...Stands out!

FULL LINE—FOR EVERY APPLICATION

Looking for a chance to cut idle machine time and unpredictable maintenance load? Here's a performance-proved opportunity—with the newly strengthened, newly styled Westinghouse Life-Line Safety Switch.

For two reasons. First, precise and positive action protects your circuits and equipment when emergency demands it. MICARTA® crossbar, now 50% to 100% stronger, assures unit action of contact blades and follow-through action of the operating mechanism.

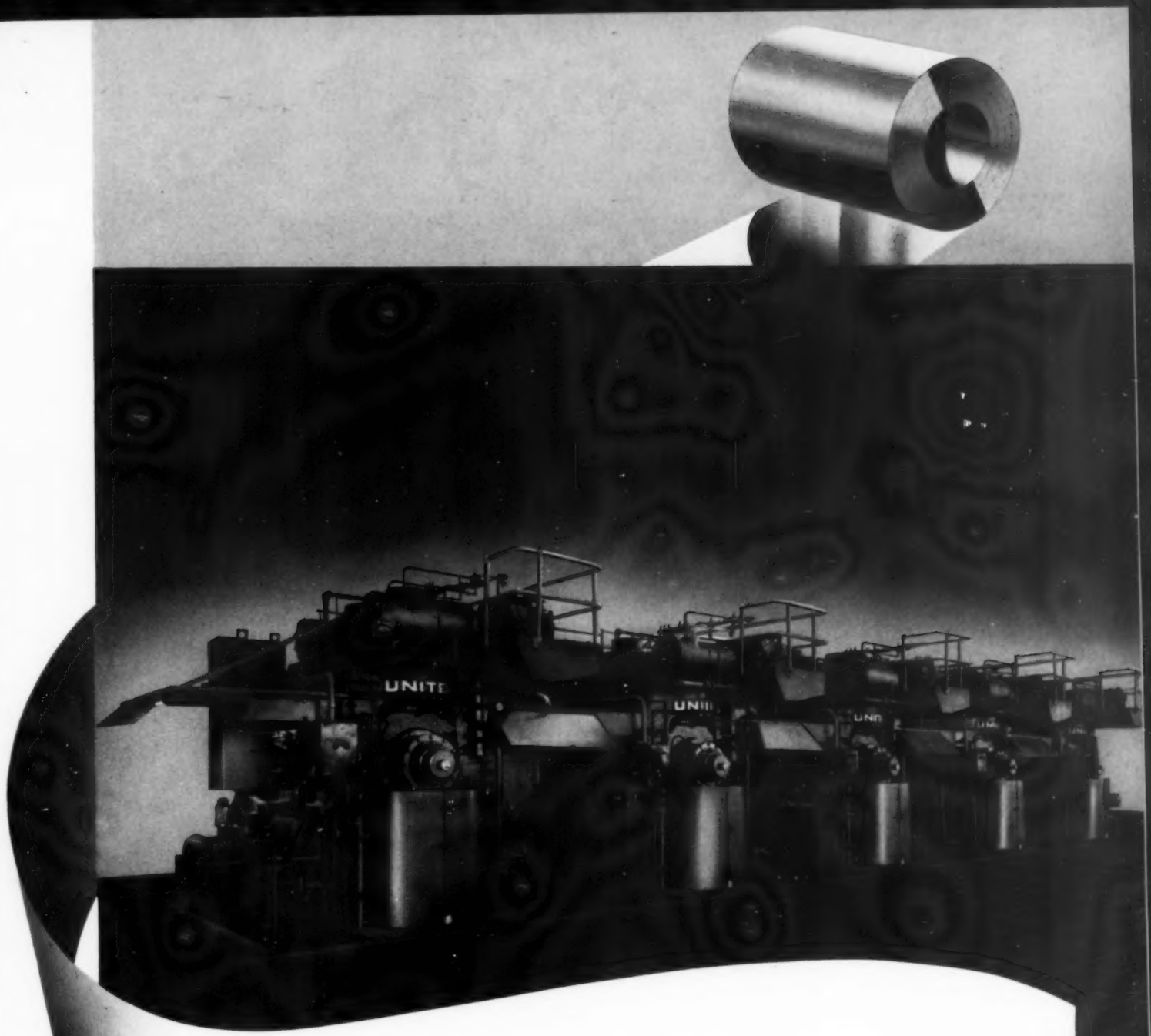
Second, Westinghouse Switches are long lived—diamond-pointed break jaw and extended blade eliminate burning of contact areas. "De-ion®" Arc Quenchers suffocate arcs in a twinkling. One-piece copper construction means fewer current-carrying joints and loose connections, resulting in less wattage loss.

Whether fused for circuit protection or unfused as a disconnect, there is a complete line of safety switches in types A, C and D for NEMA Type 1 applications.

Your Westinghouse Distributor will be glad to help you. Or write for Booklet B-5457, Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Penna.

J-30083

YOU CAN BE SURE... IF IT'S
Westinghouse
Life-Line
SAFETY SWITCHES



UNITED

5-stand Tandem 4-high Cold Mill

UNITED ENGINEERING AND FOUNDRY COMPANY

Pittsburgh, Pennsylvania

Plants at Pittsburgh · Vandergrift · New Castle · Youngstown · Canton

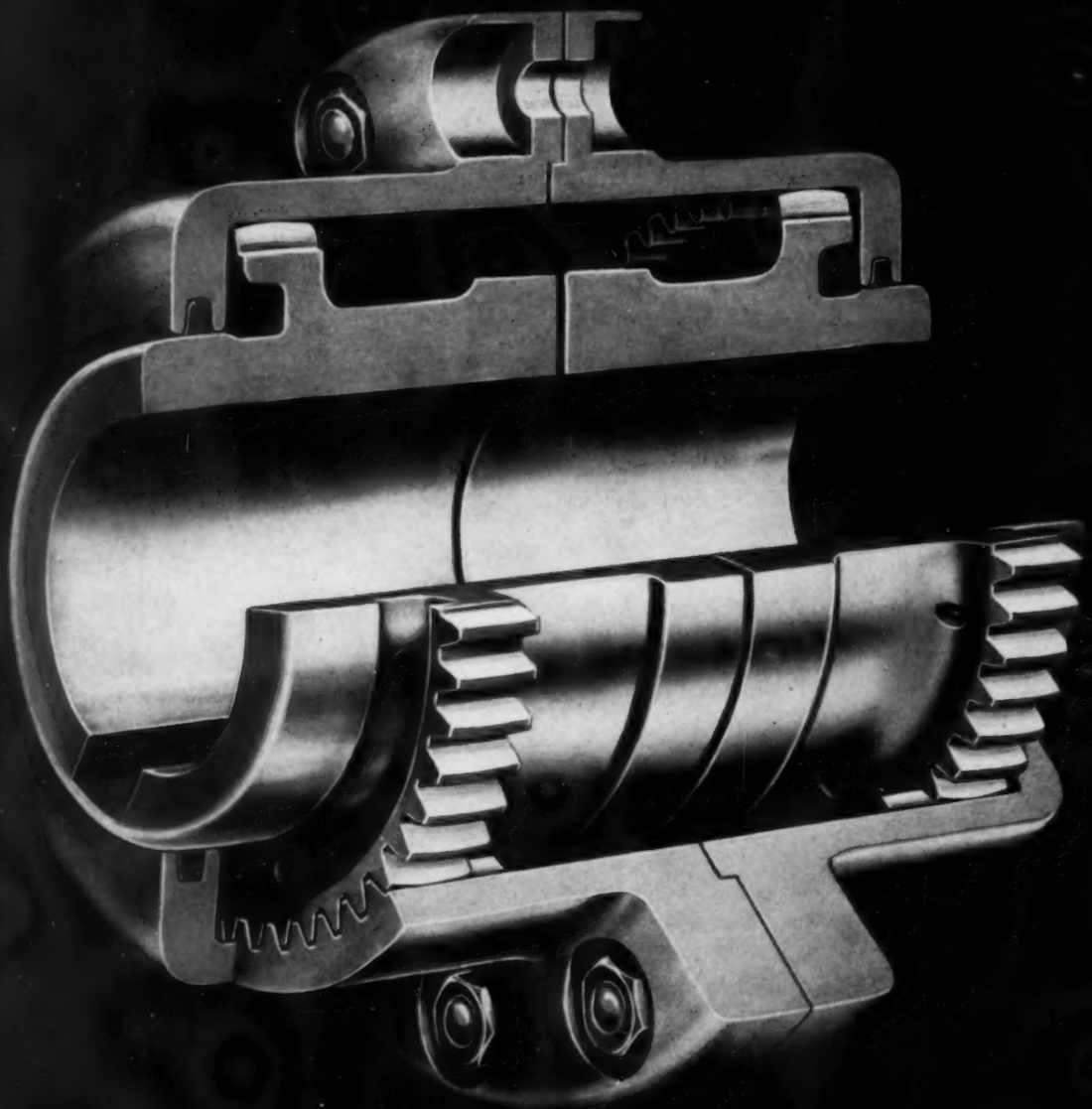
Subsidiaries:

Adamson United Company, Akron, Ohio
Lobdell United Company, Wilmington, Delaware
Stedman Foundry and Machine Company, Inc., Aurora, Indiana

UE&FCO
REG. T. M.

Designers and Builders of Ferrous and Nonferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other Heavy Machinery. Manufacturers of Iron, Nodular Iron and Steel Castings, and Weldments.

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

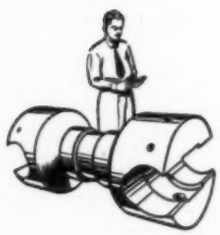
FLEXIBLE COUPLINGS

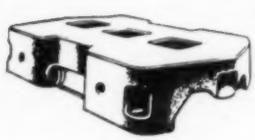
POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

First things first!

The greater part of Union's output is now earmarked for military needs . . . for equipment that demands steel castings which must stand up under unusual shock, stresses, abrasion and fatigue. Orders are being filled just as rapidly as Defense requirements will permit.





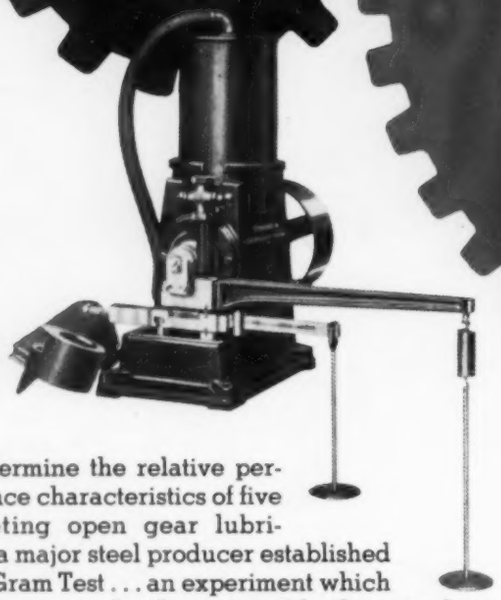
UNION STEEL CASTINGS

DIVISION OF BLAW-KNOX COMPANY, PITTSBURGH, PA.

INDEPENDENTLY CONDUCTED

4-GRAM TEST

—PROVES LEADOLENE Klingfast BEST FOR LUBRICATING OPEN GEARS



To determine the relative performance characteristics of five competing open gear lubricants, a major steel producer established the 4-Gram Test . . . an experiment which reproduces as closely as possible the actual service conditions encountered in open gear and sleeve bearing lubrication.

In this test the Timken Testing Machine, recognized as standard equipment for testing lubricants, was modified slightly to reproduce more precisely actual service conditions. The hardened and ground steel block and cup, indicated at right, normally is under constant lubrication. However, in the 4-Gram Test the flow of lubrication was cut off and 4 grams of the lubricant being tested were applied at room temperature. The machine then was set in motion and watched closely for signs of scoring.

Five lubricants, all accepted in industry as "good quality," were tested. *Results of the test showed that LEADOLENE KLINGFAST gave over 3½ times the service of the next best lubricant and up to 6 times the service of the other lubricants tested.*

Since open gears are lubricated periodically and not constantly, the pH-ilm must have lasting characteristics. Thus, this test is truly representative of actual field operation tests for open gears. The enduring action together with extremely high pH-ilm strength guarantee the machine actual lubrication and protection.

In testing . . . and more important, in actual service . . . LEADOLENE KLINGFAST regularly gives comparable performances. A product of 76 years of manufacturing experience, it is a lead-based lubricant with an "Indestructible pH-ilm," capable of withstanding pressures up to 50,000 psi. With LEADOLENE KLINGFAST you profit in two ways: from lowered lubrication costs due to less frequent application, and from greater service life from the machinery being lubricated.

Write for technical data or samples for your own testing.

THE BROOKS OIL CO.

Since 1876

Executive Offices and Plant.....CLEVELAND, OHIO
Executive Sales Offices.....PITTSBURGH, PA.
Canadian Offices and Plant.....HAMILTON, ONTARIO
Cuban Office.....SANTIAGO de CUBA

Results OF 4-GRAM TEST

LEADOLENE KLINGFAST
30 MINUTES
without scoring or failing.

LUBRICANT "A"
5 MINUTES
A high grade compound scored at 5 minutes and failed in 12 minutes.

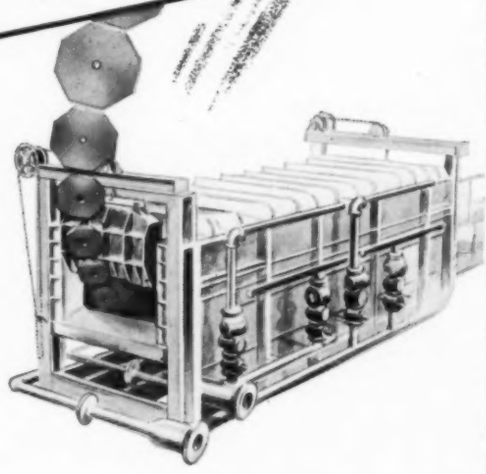
LUBRICANT "B"
8 MINUTES
A reputable lubricant of residual nature scored and failed in 8 minutes.

LUBRICANT "C"
6 MINUTES
A good lead compounded extreme pressure lubricant scored and failed in 6 minutes.

LUBRICANT "D"
6 MINUTES
A lead-compounded lubricant scored and failed in 6 minutes.

HEATING WHEEL BLANKS TO 2050° F... 100 PER HOUR

INTERMEDIATE STEPS, ROLLING, STAMPING, FORMING.



SELAS Gradiation®

HEATS WHEEL BLANKS AT RATE OF ONE EVERY 36 SECONDS . . . UNIFORMLY WITHOUT SHUTDOWNS

PROBLEM: to uniformly heat the entire surface of octagonal wheel blanks . . . to a rolling temperature of 2050° F. Blank is rolled, from hub to rim, in a series of passes, without reheating, to finish as a uniformly tapered blank. Uneven taper would result in an unbalanced wheel.

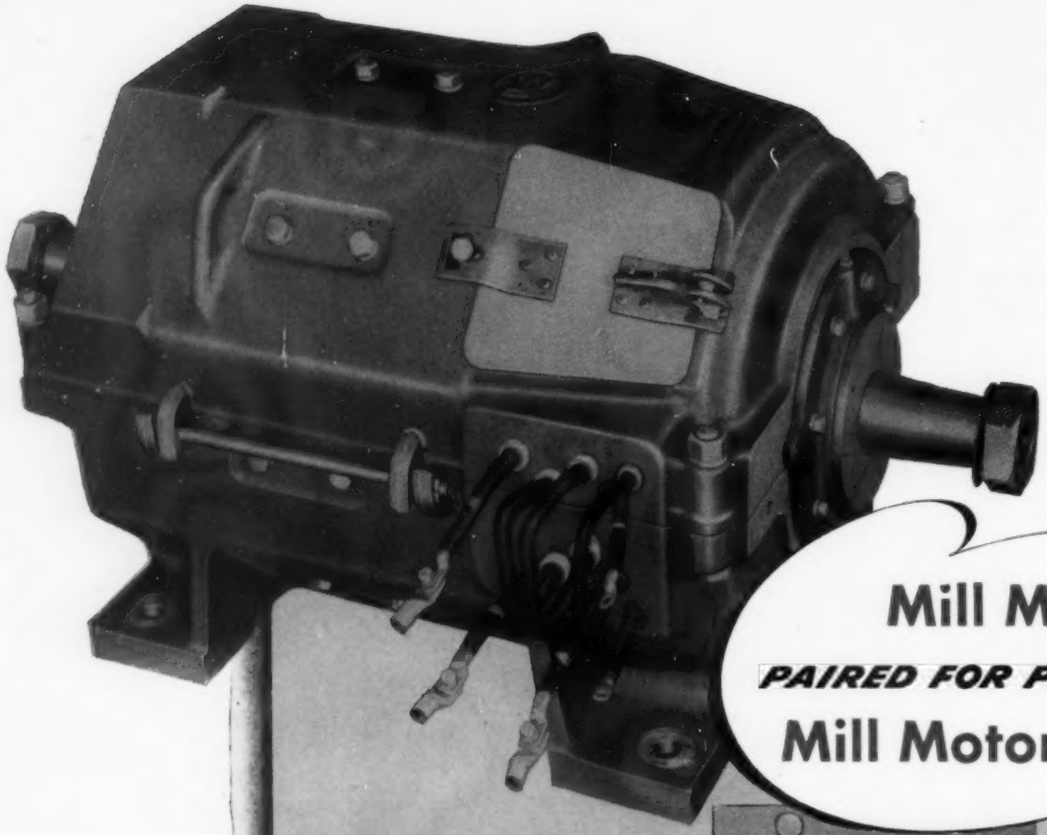
SOLUTION: Selas GRADIATION unit designed, developed and built by Selas Engineers. Handles 100 octagonal steel discs 24" across flats and .380" thick per hour. Rotating vertical spindles carry discs horizontally through radiant heat until they reach 2050° F. . . . uniformly and precisely heated. End product is improved at lower unit cost.

Selas GRADIATION utilizes high intensity radiant gas heat . . . with high temperatures . . . high speed . . . high temperature differential. Heating is uniformly precise, with controlled combustion gases providing protective atmosphere. Where production depends upon heat processing of metals, you can benefit by the experience of Selas engineers. Usually they can provide a new approach to the heating problem . . . through GRADIATION.

SELAS CORPORATION OF AMERICA

PHILADELPHIA 34, PENNSYLVANIA

Heat Processing Engineers for Industry — Development • Design • Manufacture

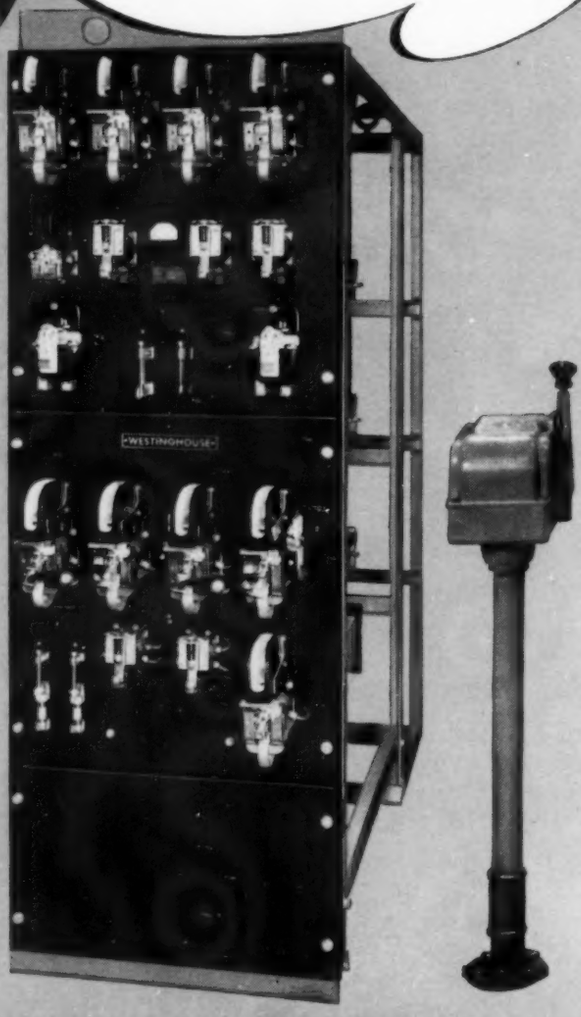


Mill Motor

PAIRED FOR PRODUCTION

Mill Motor Control

600 Series Mill Motor



Typical 9500
Line Controller, Type M
Contactors and Type SM
Master Switch

Rugged!

cut mill down time with this team

Certainly in a mill, where down time costs add up fast, the ability of equipment to stand up to rugged continuous duty is of paramount importance. That's why you'll find this combination hard to beat. They are rugged . . . made together to work together. Each incorporates the latest design features to keep production lines rolling.

Take the motor for example. The high starting torque of this new 600 series mill motor is ideal for high inertia loads . . . proved commutation . . . high rated efficiency assures maximum performance under tough service conditions . . . simplified construction makes servicing and maintenance easy. It is a brand-new motor with a new kind of performance built for today's tougher jobs.

Controllers, too, are built to assure new dependability. Main contactors are the new Type M with knife-edge, trouble-free bearings . . . with exclusive Quick-Quench arc boxes which greatly increase contact life. Overload relays are the dual thermal instantaneous type. Accelerating relays are the time-proved inductive time delay Type AZ.

The third part of this control team is the rugged Type SM master switch. Easy to operate, yet with a definite "feel" for each operating point of position, the switches are available with 2 to 6 speed control.

Together, these three offer a new kind of dependability. Get the facts on all three. Ask your nearby Westinghouse representative for a copy of the new booklet B-4730, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21647

YOU CAN BE SURE.. IF IT'S

Westinghouse

MILL MOTORS AND CONTROLS

F&Y HELPS THE NATION'S STEEL MILLS

...speed production with

PARALLOY

STEEL MILL ROLLS

PINCH ROLLS

COILER ROLLS

TENSION ROLLS

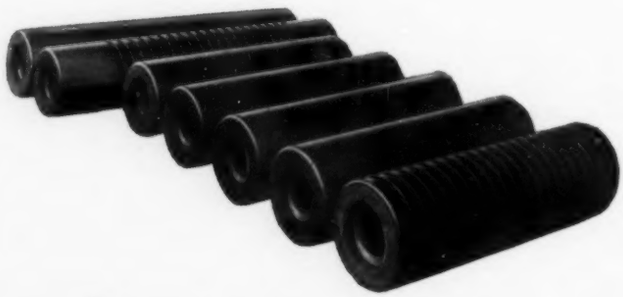
Other F&Y Products of Proven Performance

- HYDRAULIC SLAB AND BILLET PILERS
- STRIP AND SHEET OILING EQUIPMENT
- SHEET SCRUBBER AND CLEANING LINES
- HOT SAWS—ROCKING AND SLIDE TYPES
- HOT BEDS—COOLING BEDS—TRANSFERS
- BILLET EJECTORS—PINCH ROLL STANDS
- SLITTERS—SPECIAL SHEARS AND GAUGES
- TILTING TABLES—Traveling and Lifting Tables
- Continuous PICKLING Lines—ROLLER LEVELERS
- FURNACE Charging Equipment—Furnace Pushers
- Strip Steel COILERS and REELS—SCRAP BALLERS
- RAILROAD Spike Forming Machines—ROLL LATHES
- Sheet GALVANIZING Lines—Wire Patenting Frames
- Stretcher Levelers—Angle and Shape Straighteners
- Rolling Mill Tables—Gear and Individual Motor Types
- DUCTILE CASTINGS (80,000 PSI.)

Machinery Built to Customer's Design and Detail Drawings

Roll More Tons per Pass
No Scratching or Galling

500-600-BRINELL



Paralloy Rollers

F&Y

The Youngstown Foundry & Machine Co.

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

Youngstown, Ohio

8

How TIMKEN® bearings help floor charger carry 12-ton overhung load

THIS floor charger, built by The Wellman Engineering Company, charges and levels 12 tons at a crack in open hearth furnaces! The 12-ton overhung load and the terrific shock loads set up by the charging operation are carried by the peel shaft bearings. To take these loads and to keep the charger in top operating shape, Wellman engineers have mounted the peel shaft on Timken® tapered roller bearings.

Besides using Timken bearings on the peel shaft, Wellman engineers also use them at vital points, including: bridge gear shaft truck drive wheel, hoist worm gear, bridge drive input shaft, trolley travel motor pinion and rear kickup trolley wheel axle.

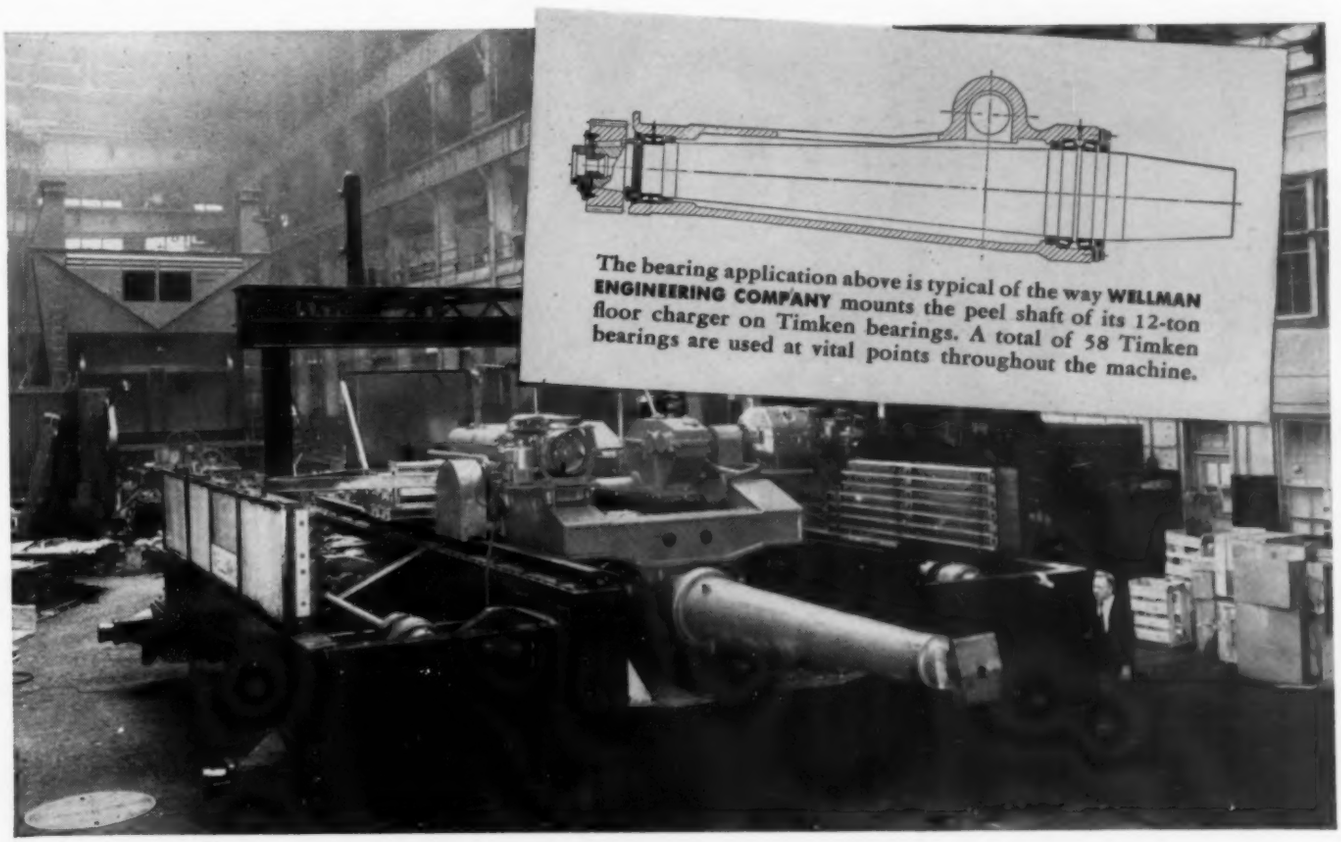
Timken bearings throughout the charger assure it of long life, dependable performance and low maintenance costs. Because of line contact between Timken bearing rollers and races, they provide extra load-carrying capacity. Shock loads set up by the up-and-down, back-and-forth motion of the charger's ram are carried easily, with capacity to spare.

Due to their tapered construction, Timken bearings carry both radial and thrust loads in any combination. No auxiliary thrust bearings are needed. The shafts in the charger are held in rigid alignment; gears and pinions mesh smoothly and accurately, minimizing wear.

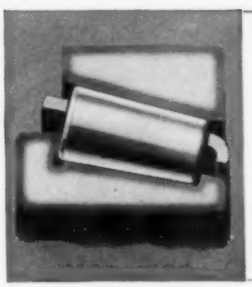
Closures are made more effective because Timken bearings hold shafts and housings concentric. As a result, lubricant is kept in, dirt kept out. Maintenance time and material costs are reduced.

Be sure to specify Timken bearings for the machines you build or buy. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



The bearing application above is typical of the way **WELLMAN ENGINEERING COMPANY** mounts the peel shaft of its 12-ton floor charger on Timken bearings. A total of 58 Timken bearings are used at vital points throughout the machine.



GREATER LOAD AREA

Because the load is carried on the *line* of contact between rollers and races, Timken bearings carry greater loads, hold shafts in line, wear longer.

The Timken Roller Bearing Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

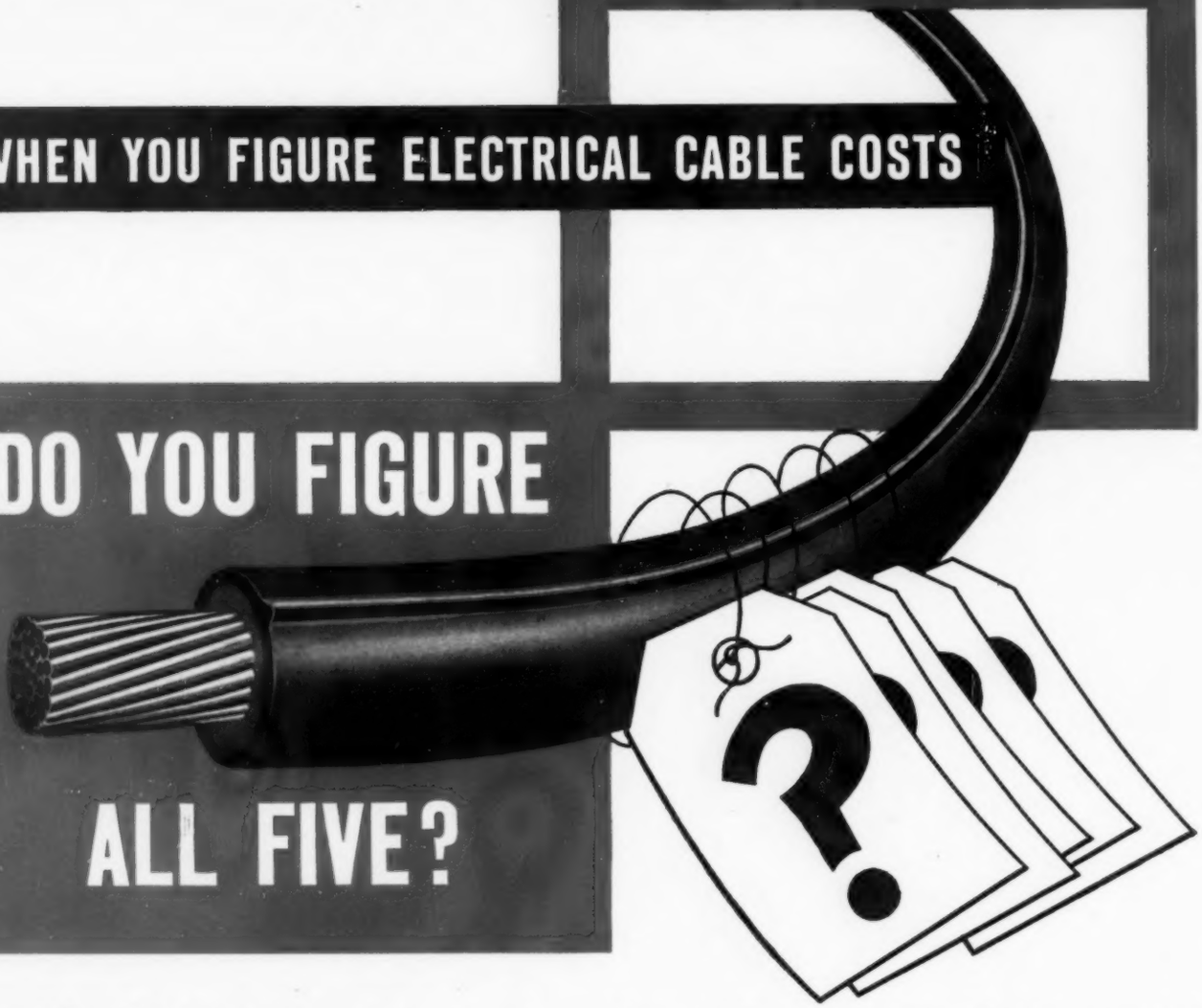
TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⓪ AND THRUST →⓪← LOADS OR ANY COMBINATION →✳←

WHEN YOU FIGURE ELECTRICAL CABLE COSTS

DO YOU FIGURE

ALL FIVE?



All too often electrical cables are purchased solely on the basis of initial cost. Actually, of course, this is only one of five factors to consider . . . and no true cost comparison can be made until the four "hidden" costs are figured.

Here are the four "hidden" costs which often upset your overall budget, particularly when you're trying to "economize":

- **installation costs**
- **maintenance costs**
- **costs of power shutdowns when a cable fails**
- **costs of replacing a cable which has failed prematurely.**

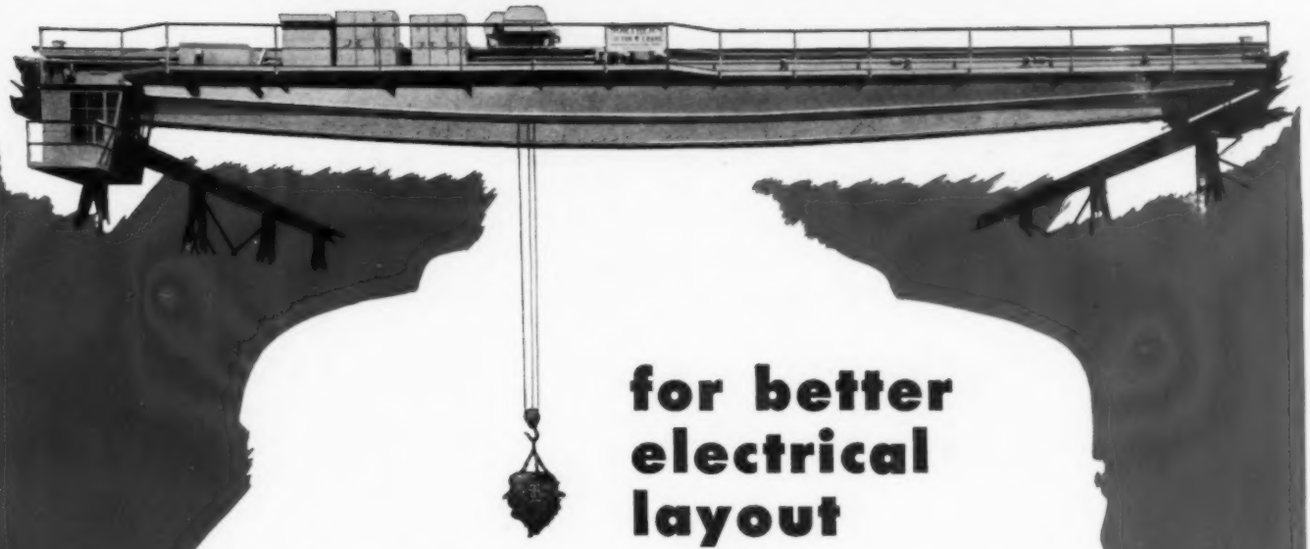
Okonite cables are the most effective means for combating these costs. A wide range of Okonite cable designs assures you of the most economical installation for any type of operating condition. And for savings throughout the life of the cable, Okonite always uses the premium materials and exclusive processing techniques which deliver unfailing electrical service year in and year out.

We can't condense millions of man-hours of cable research, field engineering and manufacturing experience into a short description of Okonite cables. But your Okonite representative can show you in black and white why the best cables – Okonite cables – really carry the lowest overall cost. The Okonite Company, Passaic, N. J.

The best cable is your best policy

OKONITE SINCE 1878 *insulated wires and cables*

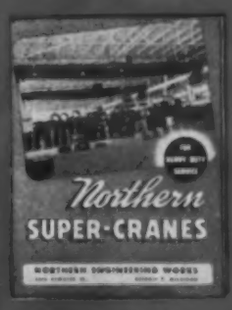
Northern Cranes



for better electrical layout

- Magnetic control panels mounted on a common support and wired as a unit greatly simplifies crane assembly, accessibility and maintenance.
- All wires, where possible, contained in metal raceways having movable covers.
- All Northern Cranes are completely wired at factory with solderless connectors, to eliminate the usual field soldering.
- Unit-welded steel construction, heavy duty roller bearings, transmission gear reductions, minimized wear on moving parts, easy accessibility, quick lubrication, simplified maintenance, and many other features reflect our experience of over 50 years in crane engineering and manufacture.

Write for new Super-Crane Bulletin SB-108-160



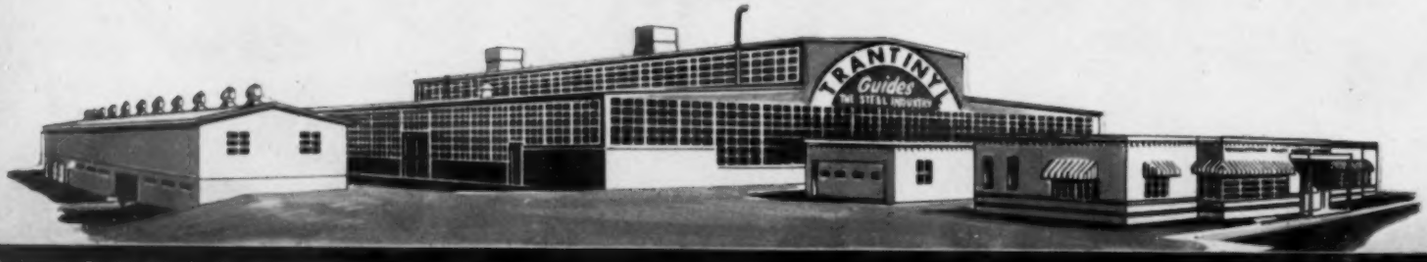
NORTHERN ENGINEERING WORKS

General Offices: 2615 Atwater St., Detroit 7, Michigan

BUILDERS OF CRANES AND HOISTS EXCLUSIVELY

TRANTINYL

guides the steel industry



YOUNGSTOWN ALLOY CASTING CORP., • YOUNGSTOWN, O.

ROLLING MILLS: bar, hoop, strip, shape mill guides, and rollers. SEAMLESS TUBE MILLS: guide shoes, rolling mill plugs and rolls, piercer points, etc. ELECTRIC WELD TUBE MILL: forming rolls, planishing rolls, tool holders, etc. • STRAIGHTENING MACHINE GUIDES • HEAT RESISTING CASTINGS

"Tycol Acylkup keeps bearings running cool... does not emulsify with water"

That's right! Tycol Acylkup Grease withstands heavy unit pressures . . . resists emulsification with water. It is easily applied by grease gun or central system.

Further, Tycol Acylkup Grease contains a high grade paraffin base cylinder oil that steps up bearing efficiency and assures increased bearing life. Protection against wear is long-lasting.

Your nearest Tide Water Associated Office will be glad to give you complete information. Call or wire today.

TYCOL

INDUSTRIAL LUBRICANTS

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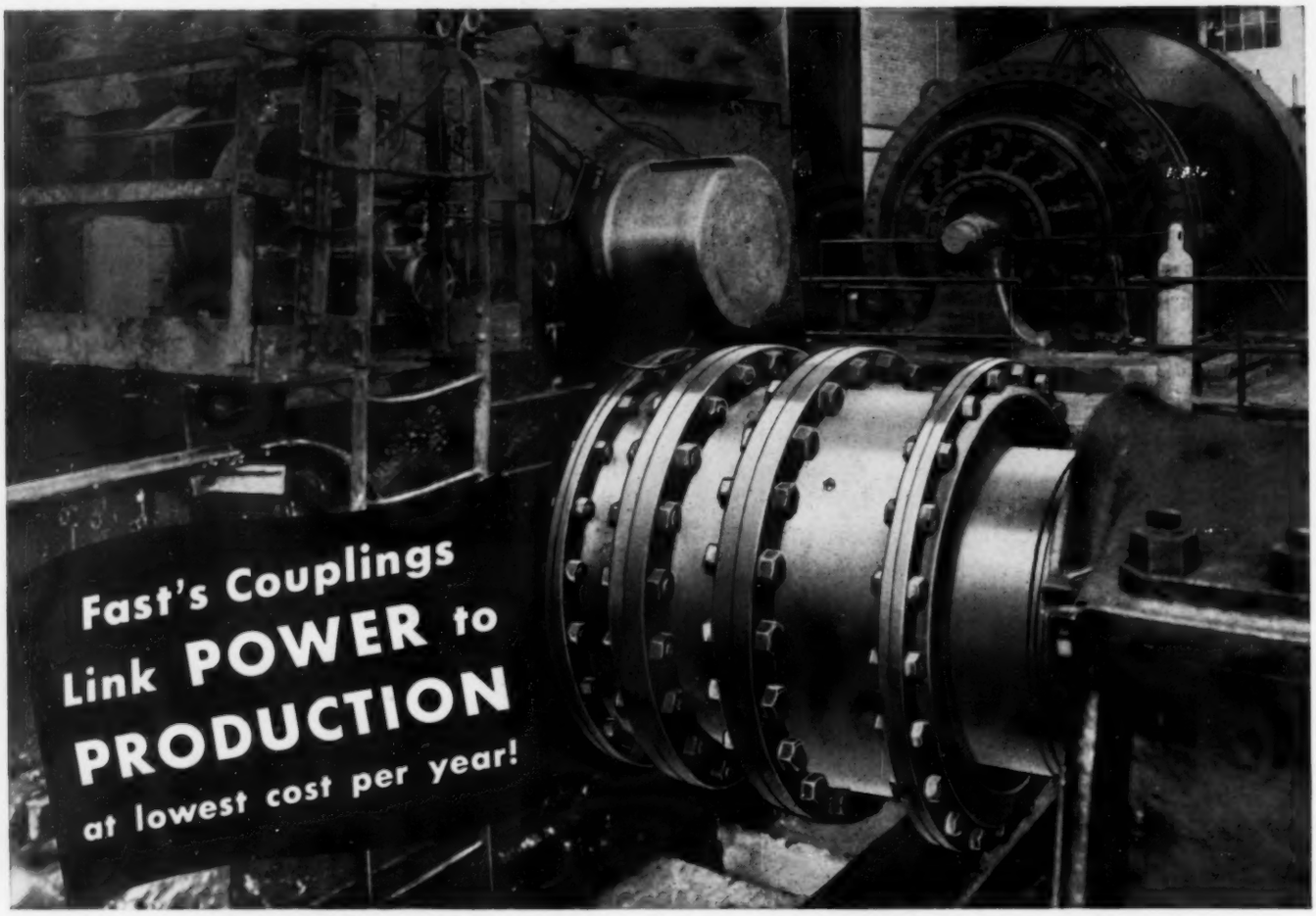
TIDE WATER ASSOCIATED OIL COMPANY

17 BATTERY PLACE · NEW YORK 4, N. Y.

SEND FOR A FREE COPY OF "TIDE WATER ASSOCIATED LUBRICANIA"



FAST'S Couplings usually outlast the equipment they connect!

ACTUAL cases on record show many Fast's Couplings are still in service after as much as 30 years of continuous operation! Time and time again, equipment has been replaced while the original Fast's Couplings remained on the job.

To you, these records of dependable, trouble-free service mean freedom from costly coupling failures when you specify Fast's. And they mean Fast's cost you far less to own and operate . . . because their cost can be amortized over long years of dependable performance.

For full details on how Fast's Couplings and Koppers Engineering Service can help you, write today for a free copy of our catalog to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 216 Scott St., Baltimore 3, Maryland.

Here's How FAST'S Save You Money

Free Service—Koppers free engineering service assures you the right coupling for the job.

Rugged Construction—Fast's still maintains its original design, without basic change or sacrifice in size or materials. Result: freedom from expensive coupling failures.

Lowest Cost per Year—Fast's Couplings usually outlast equipment they connect. Their cost may be spread over many years!

KOPPERS®

FAST'S
THE ORIGINAL
GEAR-TYPE
Couplings

INDUSTRY'S STANDARD FOR 32 YEARS

KOPPERS COMPANY, INC., *Fast's Coupling Dept.*,
216 Scott St., Baltimore 3, Md.

Gentlemen: Send me Fast's Catalog which gives detailed descriptions, engineering drawings, capacity tables and photographs.

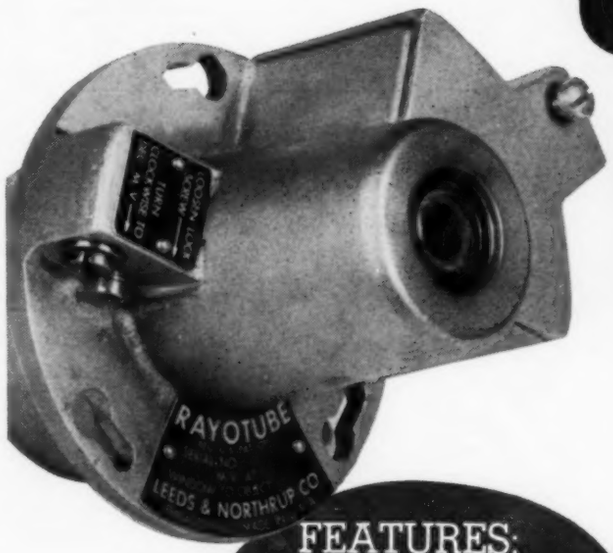
Name .....

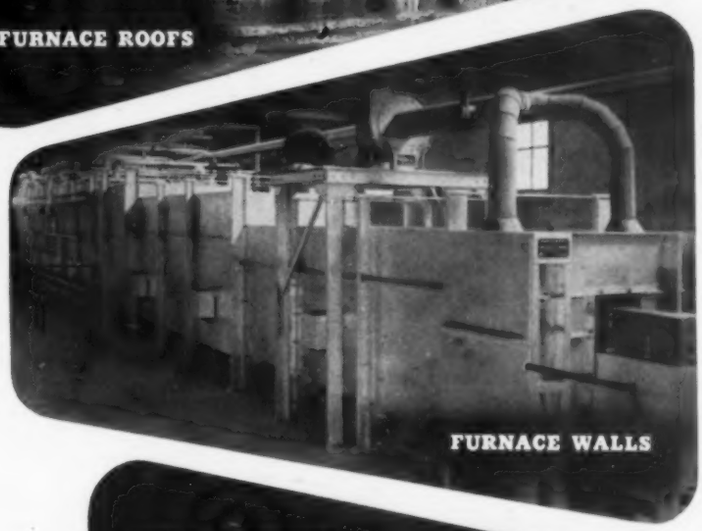
Company .....

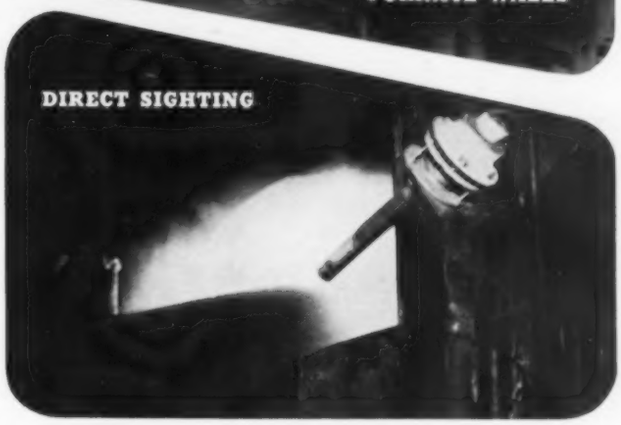
Address .....

City ..... *Zone* ..... *State* .....

This RAYOTUBE suits all locations COOL OR HOT







FEATURES:
Quick installation
" sighting
" response to temperature

Here is the radiation-sensing unit for 9 out of every ten radiation-pyrometer uses. It adds the storekeeping advantages of smaller instrument inventory to the operating advantages* of all Rayotubes. Many hundreds of this type are now in use. Among its features:

1. Easy to install because it needs no water-jacket unless the head housing itself (shown above) reaches interior temperature of 350 F. Even then, no harm is done below 450; accuracy decreases above 350, but returns fully as temperature drops. In practical operation, even 350 is reached on very, very few installations.

When replacing a present jacketed Rayotube with this type, it is not necessary to tear out the jacket and piping. Simply insert Rayotube in jacket and turn off water if no longer needed.

2. New, quick-sighting optical system shows exact area from which temperature is being recorded. This is especially helpful when instrument is being positioned to point down an open-end tube and measure directly the surface temperature of parts being heated.

3. Can be used with Speedomax electronic instruments as well as with Micromax equipment—which blanket every temperature-recording and/or controlling job in industry.

This Rayotube is No. 8890. Any L&N office, or headquarters at 4942 Stenton Ave., Phila. 44, Pa., will send details on request.

LEEDS & NORTHRUP
MEASURING INSTRUMENTS · AUTOMATIC CONTROLS · TELEMETERS
HEAT-TREATING FURNACES

Jrl. Ad NS3(3)

*Any L&N man can give details

THE NEXT MOVE IS YOURS

FOR GEAR DRIVES, PINION STANDS OR COMBINATION UNITS – built to suit your needs exactly—you only have to tell us your requirements. We will do the rest, supplying you with a *designed-for-the-job* unit capable of withstanding the shocks, stresses and wear encountered in continuous, heavy duty service.

REDUCTION GEAR DRIVES – Single, double and multiple reduction units, in a wide range of ratios and capacities. Precision cut gears, generated by the famous Farrel-Sykes process, provide extra load-carrying capacity and smooth, quiet operation.

PINION STANDS – Double or single helical pinions mounted in sleeve or roller bearings, carried in heavy cast cases and provided with automatic lubrication. Built in any size, for any capacity.

COMBINATION UNITS – Include reduction gear drive and pinion stand in a compact, integral unit.

The next move is yours. Why not call on us when planning your new mill drive? Our engineers will be glad to discuss gear drive problems with you at any time, without obligation.

FARREL-BIRMINGHAM CO., INC. • ANSONIA, CONN.
Plants: Ansonia and Derby, Conn.; Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Pittsburgh, Akron, Chicago, Los Angeles, Houston

Farrel-Birmingham

FB-477

STOP RUST! with RUST-OLEUM®

The Practical Coating!
Beautifies As It Protects!
In All Colors, Aluminum and White!

Cut maintenance costs. Apply RUST-OLEUM directly over rusted surfaces without removing all the rust! Just wirebrush and use sharp scrapers to remove rust scale and loose particles, then apply by brush, dip, or spray. Costly sandblasting and chemical precleaning are not usually required. Specify RUST-OLEUM for every rustable metal surface. Prompt delivery from Industrial Distributors in principal cities.

RUST-OLEUM CORPORATION
2441 Oakton Street, Evanston, Illinois

FREE SURVEY: A RUST-OLEUM specialist will gladly survey your rust problems. He'll make specific tests and recommendations. No cost or obligation. See Sweets for complete catalog and nearest RUST-OLEUM distributor, or write for literature on your company letterhead.

Protects Tanks, Girders Fences, Stacks, Metal Sash, Roofs, Buildings, Marine and Railroad Facilities

Look for this label. Be sure it's genuine RUST-OLEUM!

Stopping Rust with RUST-OLEUM 769 D.P. Red Primer

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MAIL TO: RUST-OLEUM CORPORATION
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- ☐ Have a Qualified Representative Call
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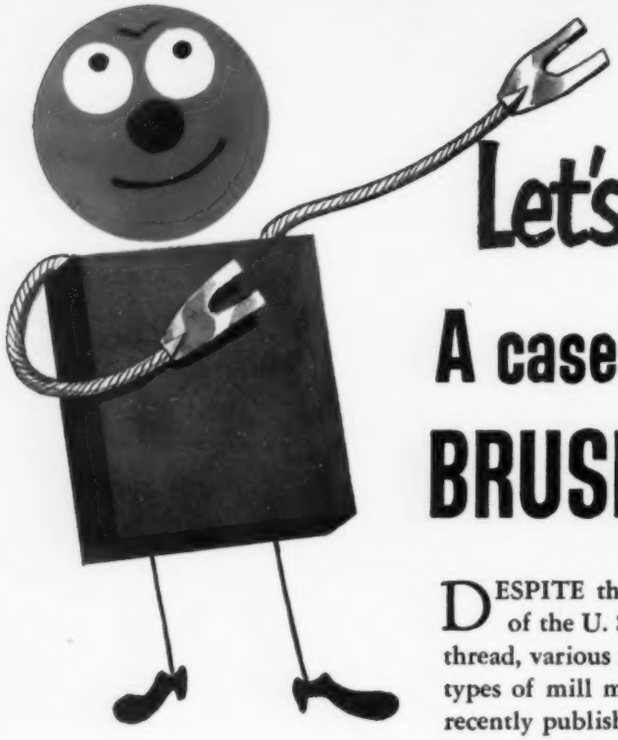


Let's all get together...

A case for further BRUSH STANDARDIZATION

DESPITE the fact that practically every component and sub-assembly of the U. S. industrial machine is today as STANDARD as the Acme thread, various mill operators still stock and specify thousands of different types of mill motor brushes – *most* of them differing only slightly from recently published *AISE mill motor brush standards.*

Long aware of the advantages of brush standardization, National Carbon Company offers a brush to match every one of the AISE mill motor brush standards – plus the further advantages of *shipment from stock* for all the commonly used types.

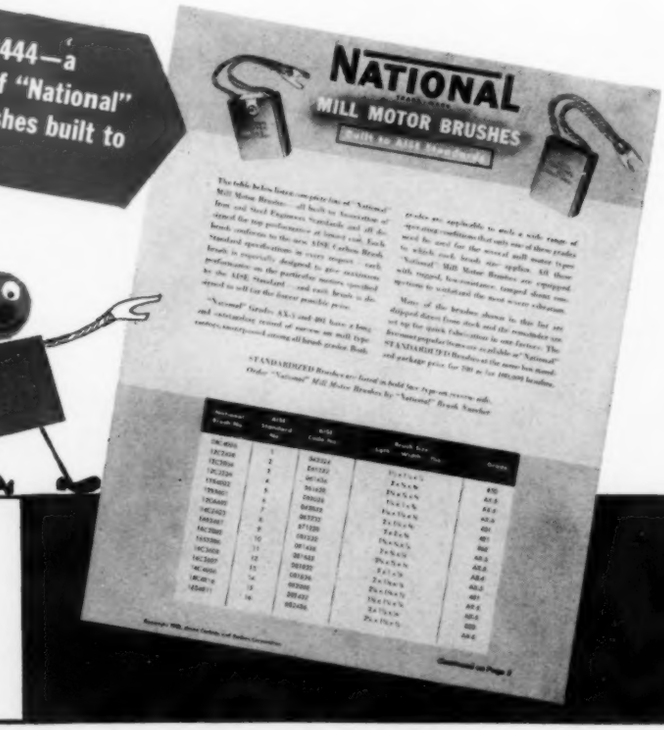
"National" STANDARDIZED Mill Motor Brushes (listed at left) come to you at the same low unit price for 100 or 100,000 brushes, sturdily packaged for convenient handling and storage.

We're off to a good start. Let's *keep going together* – toward *further* standardization and more economical, efficient operation for YOU!

AISE standard numbers for "NATIONAL" standardized Mill Motor Brushes

NC NUMBER	AISE STANDARD NUMBER
20-4800	STD NO. 21
20-5600	STD NO. 25
24-4800	STD NO. 29
24-5600	STD NO. 30
24-6400	STD NO. 32

Write for CP-2444—a complete list of "National" Mill Motor Brushes built to AISE standards.



The terms "National", "Eveready" and the Three Pyramids device are registered trade-marks of Union Carbide and Carbon Corporation

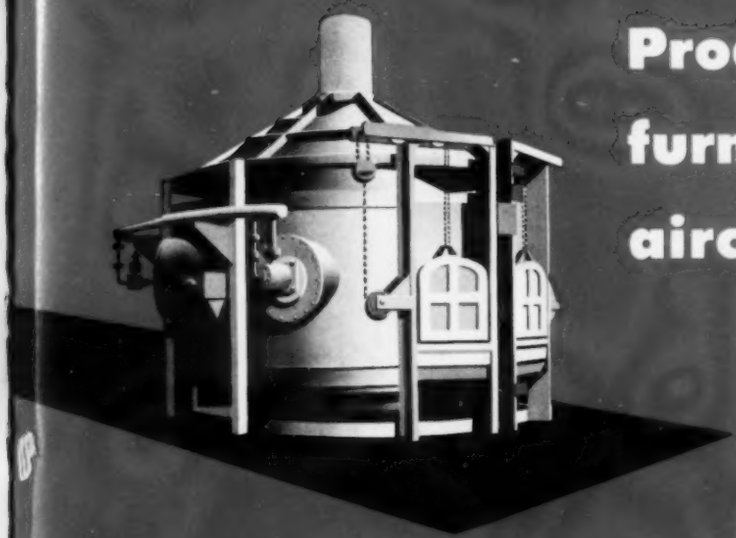
NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.
District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
IN CANADA: National Carbon Limited, Montreal, Toronto, Winnipeg

WHY BUY THIS ITEM?

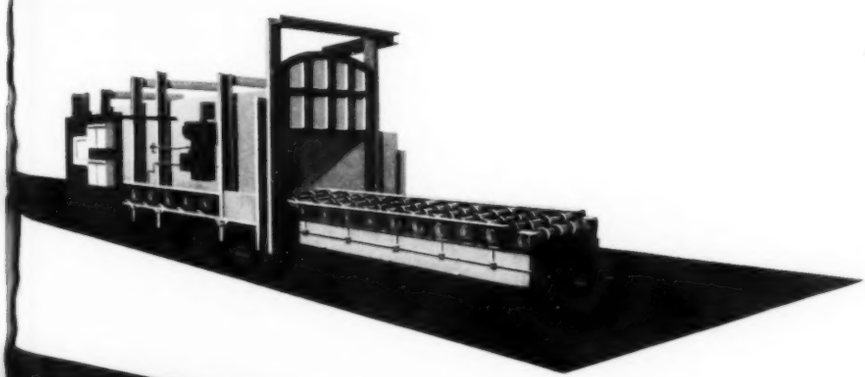
It gives you double the usable light!
No metal can to leak or corrode!
It can't stick, swell or jam!
It delivers the whitest, brightest light!

It's the "Eveready" No. 1050 flashlight battery, made with the zinc electrode inside a carbon jacket – just the reverse of every other battery on the market!

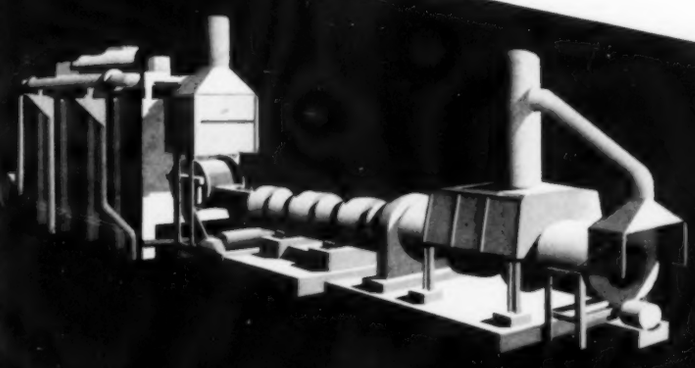
Test it and . . . you always buy it!



Production heating furnaces for guns, shells, aircraft or engine parts



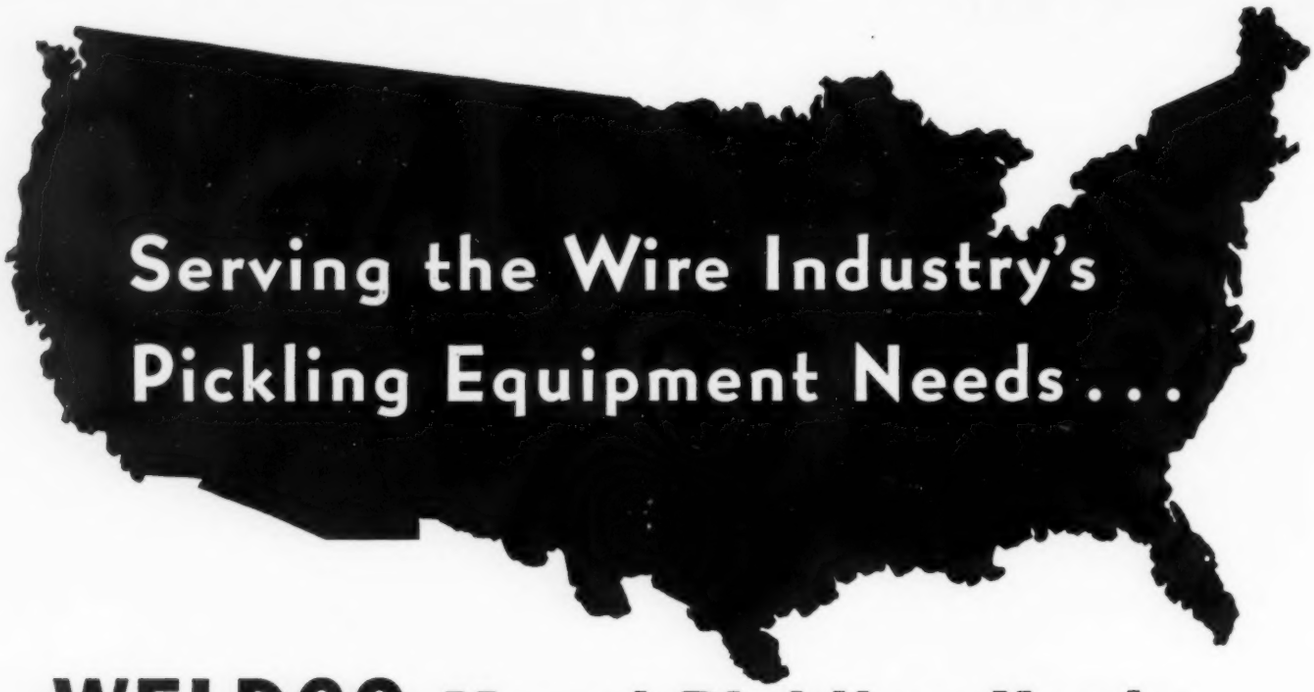
Prominent among the many services offered by Salem-Brosius to the metal-working industry, both ferrous and non-ferrous, is the design and construction of heating and heat-treating furnaces specially adapted to defense production. Whether you produce aircraft, ordnance, armor, engine parts, or a multitude of similar and associated items, the experienced staff at the Salem Engineering Division is prepared to help you . . . to build furnaces for you that cut cost and add production. Remember, if you have a problem which involves the use of furnaces, blast furnace equipment, or charging and manipulating machines, it will pay you to call on highly diversified Salem-Brosius today.



SALEM-BROSIUS, INC.

SALEM ENGINEERING DIVISION, SALEM, OHIO

BROSIUS DIVISION, PITTSBURGH 15, PA.



Serving the Wire Industry's Pickling Equipment Needs...

WELDCO Monel Pickling Hooks

Are Used In These Mills:

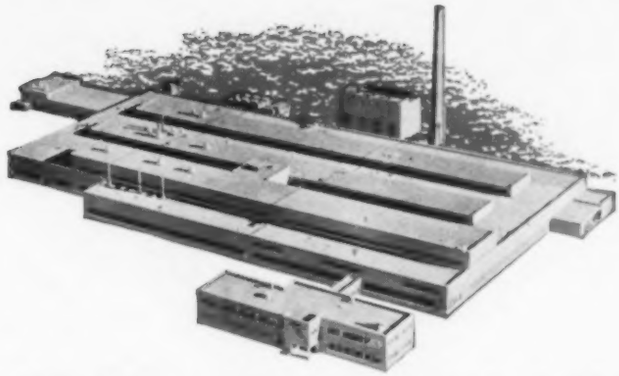
American Steel & Wire Company - - - - Joliet, Ill.
Bethlehem Steel Corporation - - Sparrows Point, Md.
Bethlehem Steel Corporation - - - Williamsport, Pa.
Detroit Steel Corporation - - - - - Portsmouth, Ohio
Electric Auto-Lite Company - - - - Port Huron, Mich.
Indiana Steel & Wire Company - - - - Muncie, Ind.
Jones & Laughlin Steel Corporation - Aliquippa, Pa.
Keystone Steel & Wire Company - - - - - Peoria, Ill.
Lamson & Sessions Company - - - Cleveland, Ohio
Mid-States Steel & Wire Company - Crawfordsville, Ind.
National Screw & Manufacturing Co. - Cleveland, Ohio
Pittsburgh Steel Company - - - - - - Monessen, Pa.
Reed & Prince Company - - - - - Worcester, Mass.
John A. Roebling & Sons Company - - Roebling, N. J.
Russell, Burdsall & Ward
Bolt & Nut Company - - - - - - - Rock Falls, Ill.
Timken Roller Bearing Company - Gambrinus, Ohio
Washburn Wire Company - - - - - New York, N. Y.
Wickwire Spencer Steel Division - - - Buffalo, N. Y.

OTHER WELDCO PICKLING EQUIPMENT

Mechanical Picklers, Crates, Baskets, Racks, Chain, Steam Jets, and Accessories

WELDCO

THE YOUNGSTOWN WELDING & ENGINEERING COMPANY
3724 OAKWOOD AVENUE · · YOUNGSTOWN 9, OHIO



N-B-M Meadville . . . where the welcome mat is out. We're proud of this plant—its equipment and the skilled people who work in it. Proud enough, in fact, to offer a standing invitation to Blast Furnace Superintendents or other steel mill officials to visit us. When can *you* make an inspection trip?

These CASTINGS have "RUN THE GAUNTLET"

Here's where you'll find copper castings that have been subjected to rigid tests for soundness and quality.

Another Reason why N-B-M Meadville is a name to remember when you specify copper castings. What does your eye tell you when you see this picture? Chances are, "a big selection of copper castings". And, it's true that this big selection is typical of the wide range of copper castings that N-B-M Meadville is equipped to produce.

But, there's something more important that no ordinary photograph can show . . . because each of these castings has its own "success story". Each has been subjected to the most painstaking system of production and quality control that you'll find in any foundry . . . anywhere. That's why we say that castings reaching our shipping room have "run the gauntlet" . . . *we know they're right.*

From the molding floor to the shipping room, N-B-M Meadville accomplishes what should be, and is, the main objective of this modern, well-manned plant . . . ***what you specify . . . we ship.***

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION

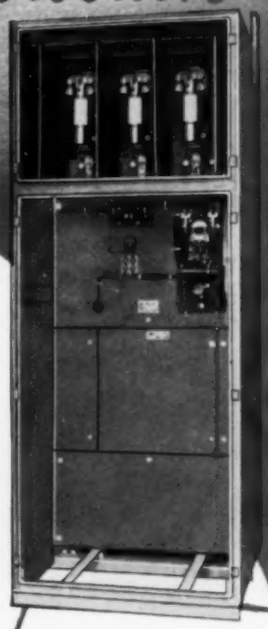
4936 Manchester Avenue • St. Louis 10, Mo.

PLANTS IN: ST. LOUIS, MO • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

CLARK HIGH VOLTAGE MOTOR STARTERS *insure* COMPLETE *Protection*

Standardized High Voltage Starters with either AIR-BREAK or OIL-IMMERSED line Contactors for *squirrel-cage, synchronous and wound rotor motors up to 700 horsepower.*

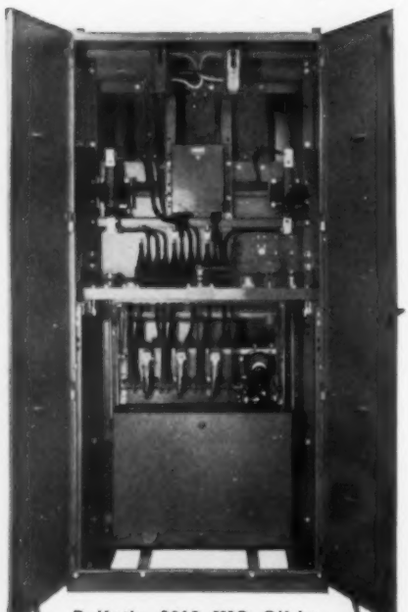
Engineered and built to meet industrial and utility requirements.



Bulletin 6018 HIA Air Break Starter for Squirrel Cage Motors —front cover removed.

CLARK TYPE HIA AIR-BREAK STARTERS

CLARK High-Voltage Starters with AIR-BREAK heavy duty direct acting Contactors feature 150,000 KVA interrupting capacity disconnecting type fuses (2300 volt, 3 phase, 60 cycle)—overload and undervoltage protection—potential transformer with primary fuses for 220 volt control circuit.



Bulletin 6018 HIO Oil-immersed starter for Squirrel Cage Motors—Rear view with doors open and oil tank lowered, showing contactor.

CLARK TYPE HIO OIL IMMERSED STARTERS

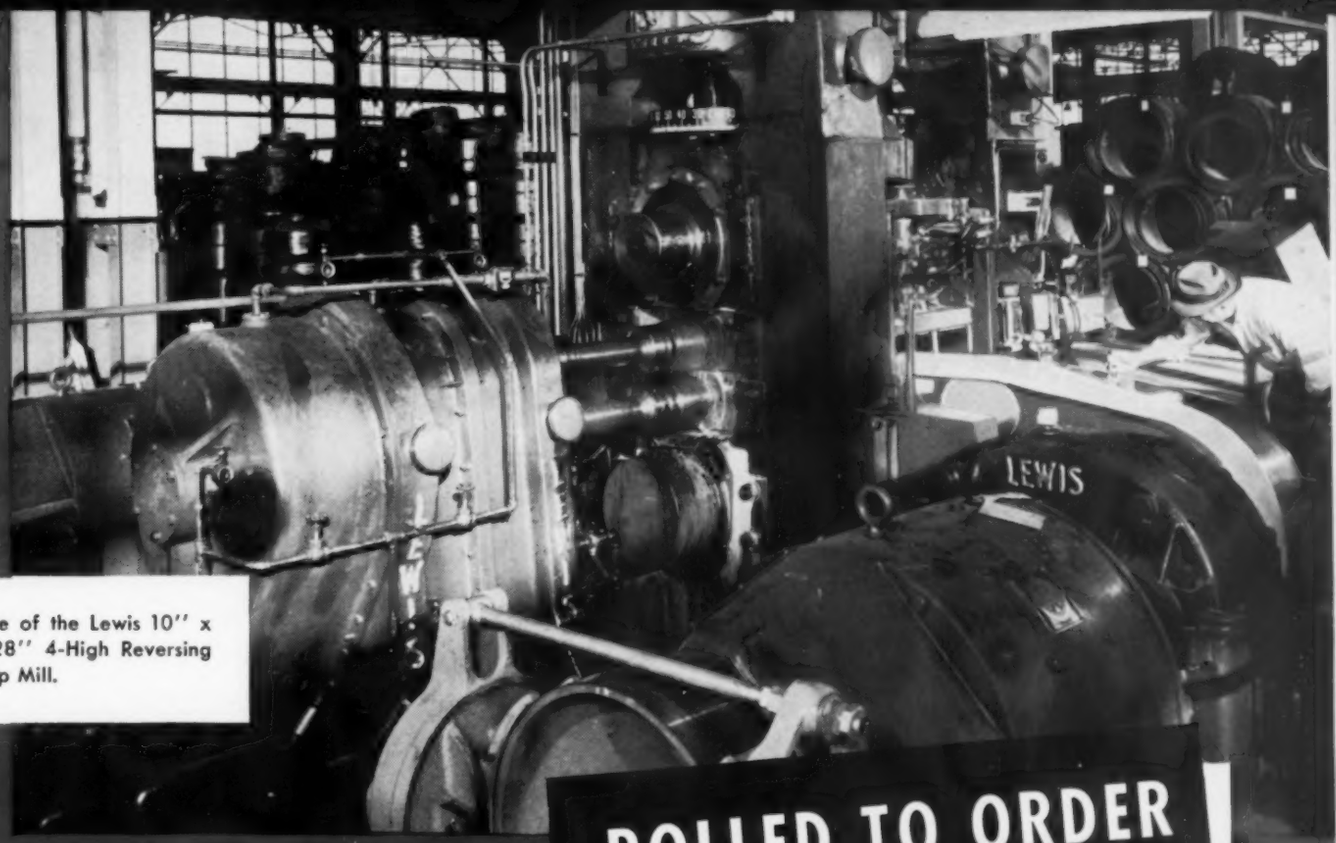
CLARK High-Voltage Starters with OIL-IMMERSED heavy duty direct acting Contactors feature 150,000 KVA interrupting capacity fuses for 2300 volts or 250,000 KVA fuses for 4160/4600 volts (3 phase, 60 cycle)—overload and undervoltage protection—potential transformer with primary fuses for 220 volt control circuit.

All CLARK High-Voltage Starters are enclosed in standardized reinforced steel cubicles with separate compartments for High and Low voltage equipment. Electrically interlocked doors. General Purpose, Semi dust-tight, Weather Resisting and Dust-tight enclosures available.

Please contact us for complete details covering the many features of these standardized High Voltage Starters. Offices in principal cities.

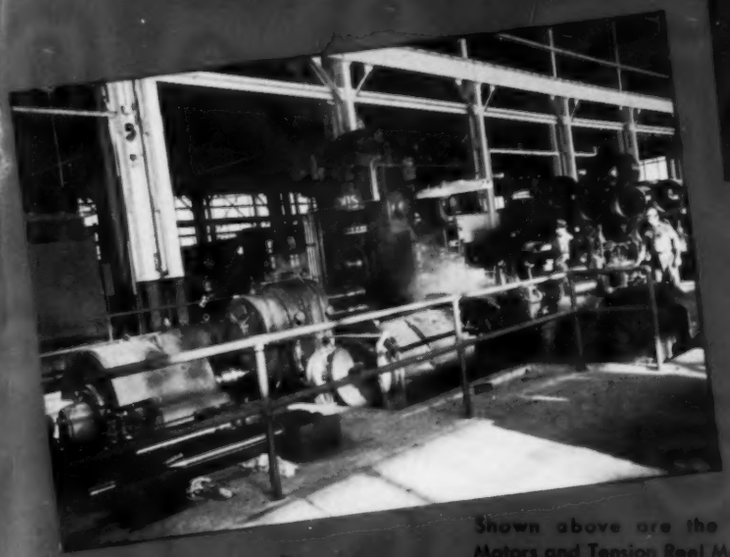
THE CLARK CONTROLLER CO.

ENGINEERED ELECTRICAL CONTROL • 1146 EAST 152ND STREET, CLEVELAND 10, OHIO

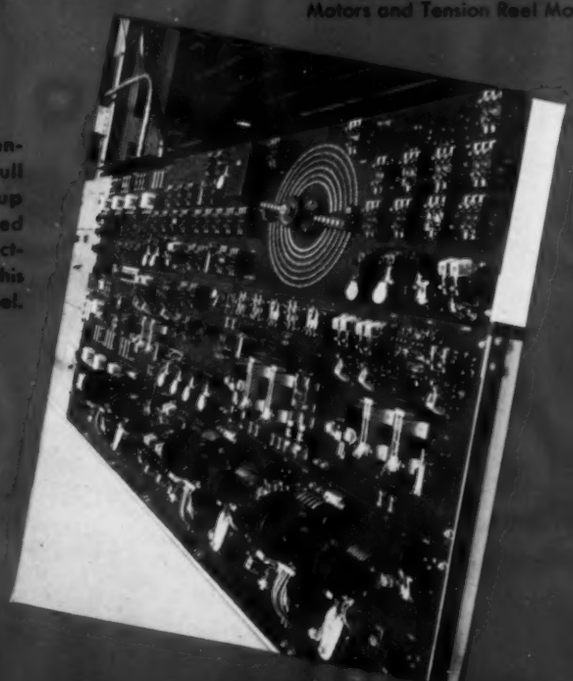


Entry side of the Lewis 10" x 20" x 28" 4-High Reversing Cold Strip Mill.

ROLLED TO ORDER -to Your Specifications



Shown above are the Mill Motors and Tension Reel Motor.



Constant tension over full coil build-up and Mill speed range is effected through this Control Panel.

When Production Steel Coil Co. Inc. gets a request for cold rolled strip of unusual width, gauge, temper and finish, they don't put the customer off with a "not in stock" excuse. They roll the order to exact specifications right in their Detroit warehouse on a Lewis 10" x 20" x 28" 4-High Reversing Cold Strip Mill! Reversing coils permit continuous operation with substantial reductions per pass, and close gauge tolerances are maintained with the most advanced pushbutton controls. This mill, together with its annealing equipment provides an exceedingly flexible arrangement that meets all customers' requirements. Write for complete technical details.

Manufacturers of Rolls and Rolling Mill Equipment For the Iron, Steel and Non-Ferrous Industries

LEWIS

FOUNDRY & MACHINE

Division of Blaw-Knox Company

Pittsburgh, Pa.

Morgan Guide Grinder

produces accurate twist guides

One of the important factors contributing to the smooth operation of your rolling mill . . . and higher product quality . . . is the accuracy of your twist guides.

This Morgan Guide Grinder was specifically designed for that purpose. It is hydraulically operated and imparts the correct degree of twist with smooth accurately formed grooves. Ground guides eliminate scratching and deliver a higher quality product.

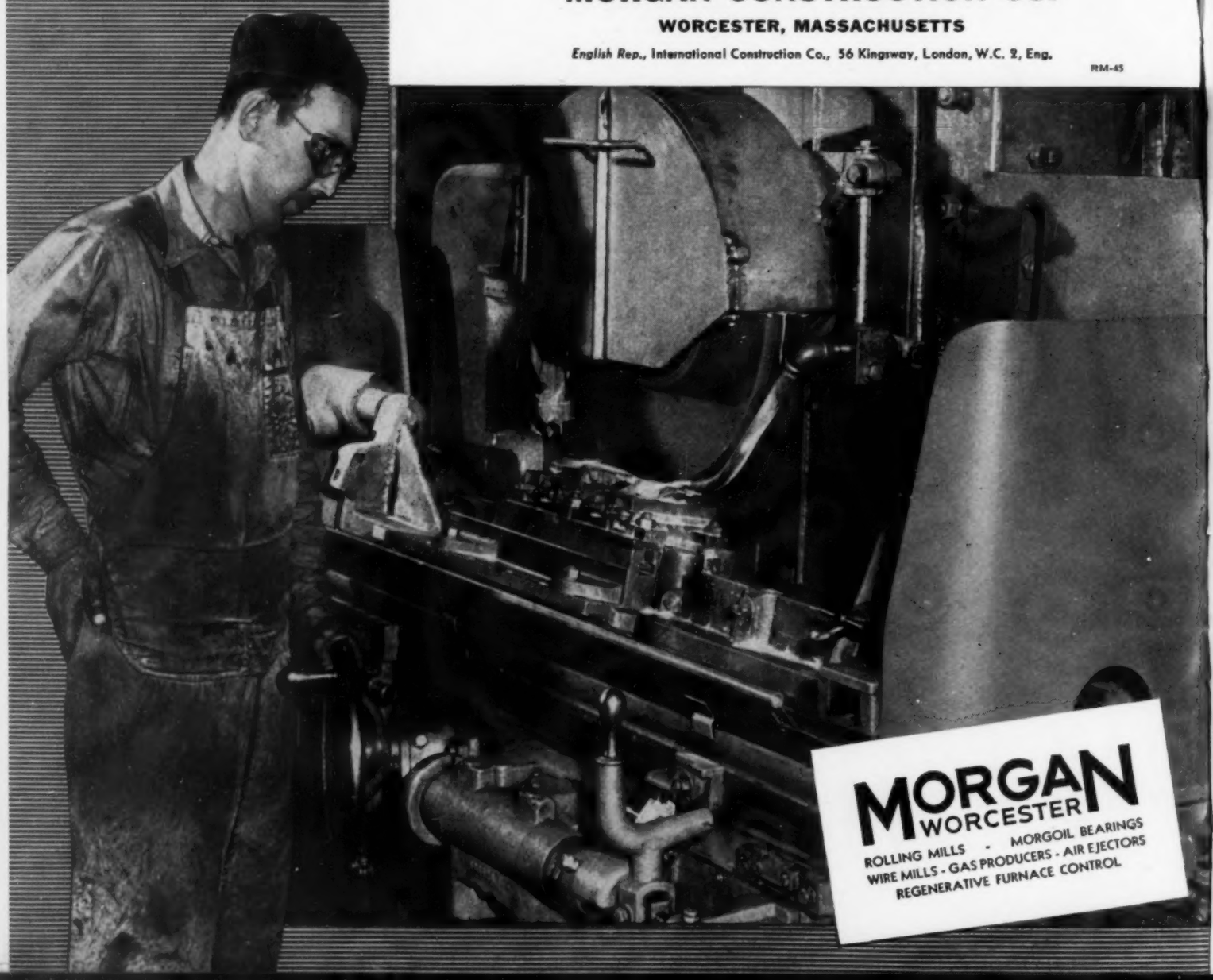
Send for complete information.

MORGAN CONSTRUCTION CO.

WORCESTER, MASSACHUSETTS

English Rep., International Construction Co., 56 Kingsway, London, W.C. 2, Eng.

RM-45



MORGAN
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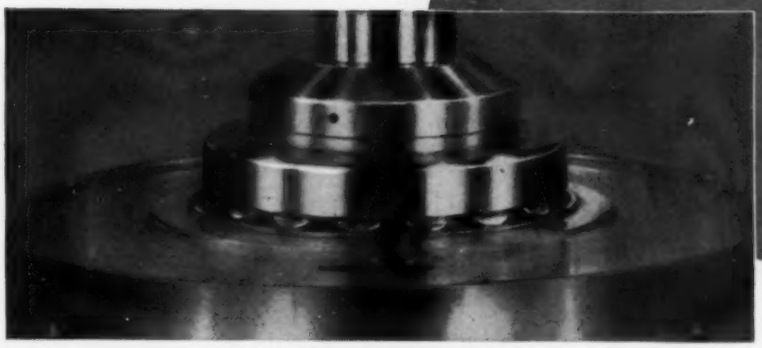
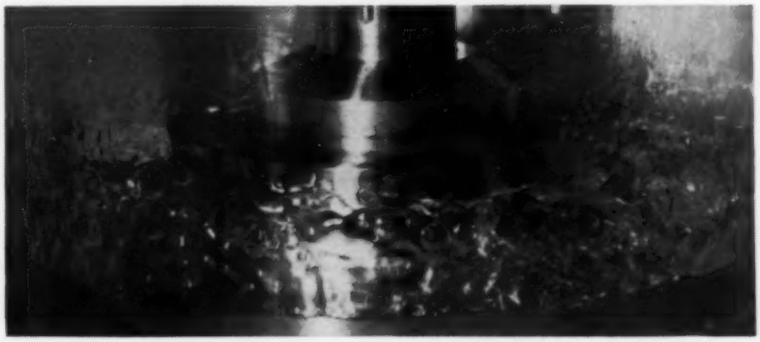
ROLLING MILLS - MORGOIL BEARINGS
WIRE MILLS - GAS PRODUCERS - AIR EJECTORS
REGENERATIVE FURNACE CONTROL

Here's the Bearing

for Heavy THRUST LOADS At High Speeds



SKF Spherical Roller Thrust Bearing showing typical vertical mounting prior to operation. Note the static oil level and compare it to the oil action illustrated below.

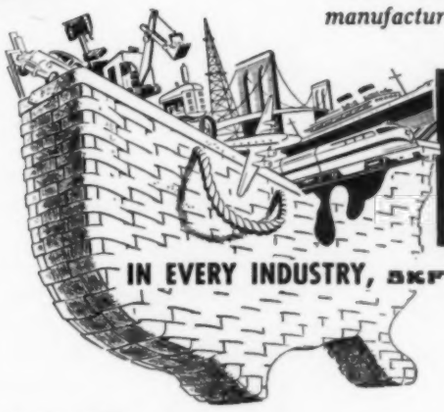


As the bearing rotates note how the lubricant is pumped outwardly along the rollers against the inner ring guide flange. This design assures perfect lubrication, low torque, long, trouble-free life.

SKF Spherical Roller Thrust Bearing is your answer where the problem is to support heavy thrust loads at high speeds on vertical or horizontal shafts.

- It has High Thrust Capacity — designed to carry heavy thrust loads, or combined loads which are predominantly thrust.
- It Is Fully Self-Aligning — has a single row of rollers which roll on a spherical outer race with full self-alignment.
- It Has A Ring-Centered Cage — constructed so lubricant is pumped directly against inner ring's high guide flange.
- It Has Low Friction Torque — an efficient oil film is developed between the roller and surfaces and the guide flange, when running.

Catalog #285 gives you all the dimensional data on SKF Spherical Roller Thrust Bearings. Send for your copy to **SKF INDUSTRIES, INC.,** PHILADELPHIA 32, PA.,— *manufacturers of* SKF *and* HESS-BRIGHT *bearings.* 7332



SKF®
BALL AND ROLLER BEARINGS

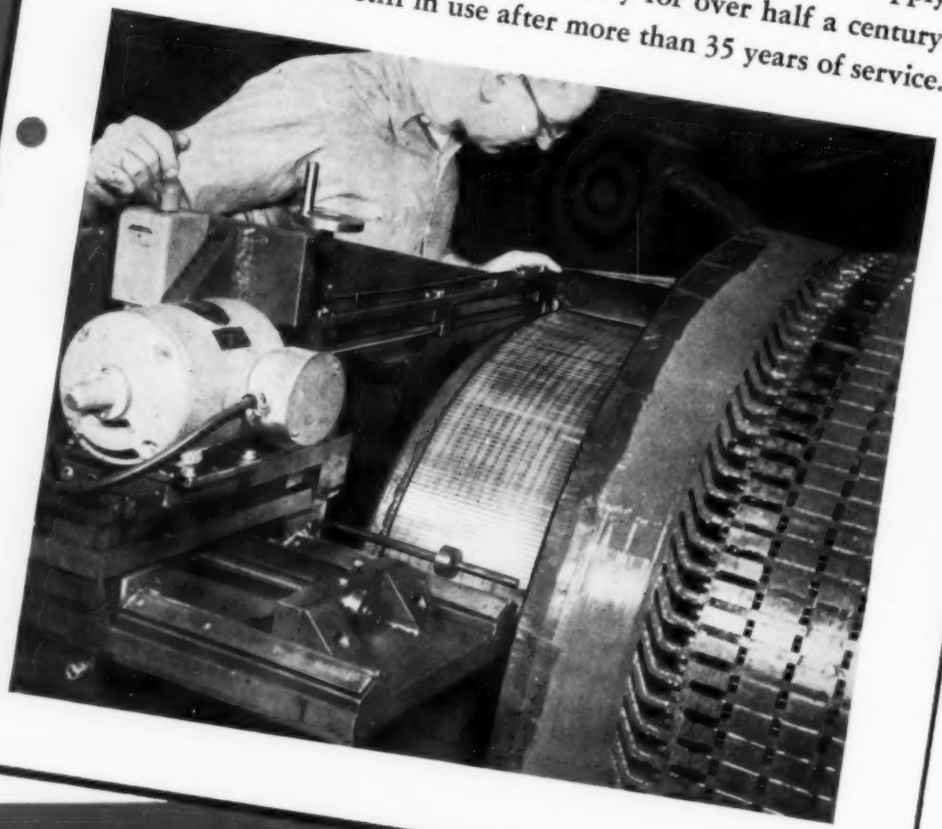
IN EVERY INDUSTRY, SKF Puts The Right Bearing In The Right Place

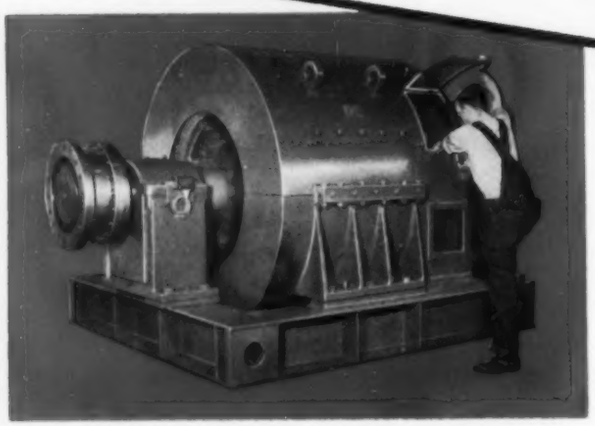
ANOTHER* EXAMPLE OF **ELLIOTT** Excellence IN MOTORS

*Precision Workmanship

in the careful undercutting of commutator mica segments, is characteristic of the painstaking attention to detail which insures dependable performance in Elliott large direct-current motors.

This extreme care in all stages of design and manufacture, is traditional with Elliott motors. Elliott shops have been supplying direct current machines to industry for over half a century. Some of them are still in use after more than 35 years of service.





The Elliott Mill Type DC Motor shown at left is rated 1000 hp, 200/400 rpm, 600 volts, with force ventilation covers including removable hinged doors of clear plastic for ready inspection and maintenance of commutator and brushes. This motor is driving a reversing cold strip mill.

ELLIOTT Company

DEPT. IS

Ridgway Division

RIDGWAY, PA.

R2-7

For motors 1—200 HP: Crocker-Wheeler Div., Ampere, N. J.

Plants at: JEANNETTE, PA. • RIDGWAY, PA.
AMPERE, N. J. • SPRINGFIELD, O. • NEWARK, N. J.
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If You Want To REDUCE MANPOWER TURNOVER...

CUT HANDWORK CASUALTIES AND COSTS...

LET THE BILLETEER DO IT...

Be production-wise — go modern, with time-proven BONNOT BILLETEERING!

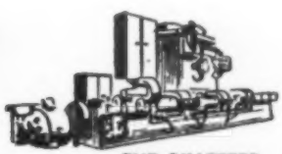
Right away manpower shortages and turnover problems solve themselves because OPERATORS appreciate the safety and speed and easy, finger-tip control of the *Bonnot Billeteer.*

And YOU — with the speed and efficiency of *Bonnot Billeteering,* can better meet today's "quantity and quality" demands by stepped-up output of better-conditioned billets. *Billeteering* also enables you to reduce inventories — makes chips 100% recoverable — eliminates excessive re-melting — guarantees accurate scheduling — reduces inventory.

Your inquiry will bring prompt facts and figures on what can be done in your plant to meet the production demands and the cost problems of today's rapidly accelerating mobilization market.

Engineered for Improved Production

The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO



THE BILLETEER

Also Manufacturers of — SAWING • CRUSHING • PULVERIZING AND MIXING EQUIPMENT • BILLET INSPECTION TABLES
DUST PUG MILLS • SINTER PLANT PUG MILLS

How to crack down on down-time!

You can speed steel furnace bottom repair—save lost production time between heats—when you use Permanente 84 *periclase* ramming and patching mix.

Patented Permanente 84 is processed from high-purity sea water magnesia. With a high MgO content, it provides an unbeatable combination of high refractoriness and chemical resistance—essential to satisfactory repair.

The high density and chemical purity of Permanente 84 minimizes penetration and attack of slag and metals. And it is dependable and easy to use.

It will pay you to specify Permanente 84 for open hearth and electric furnace rebuilds as well as for bottom, bank and tap hole maintenance.

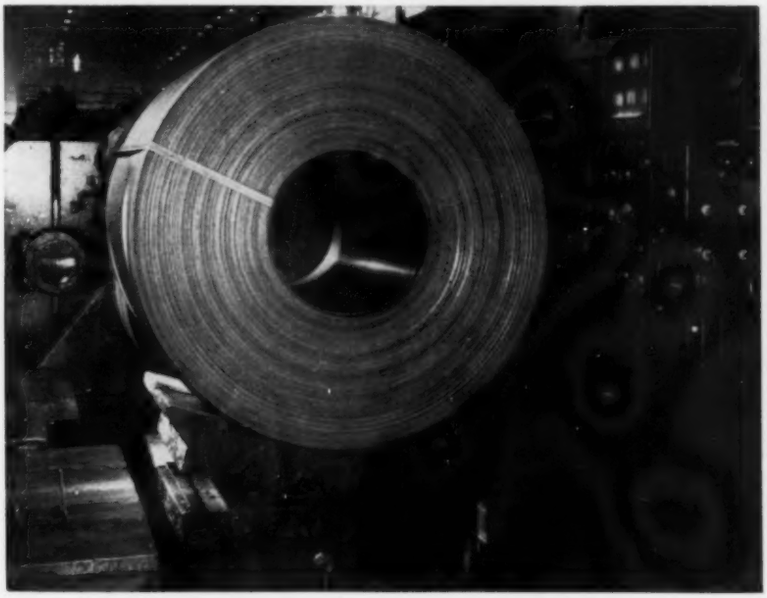
Your Kaiser refractory engineer will give prompt attention to your refractory problem—will offer, where desired, research, design and installation service to give you maximum production most economically. Write for descriptive literature on Permanente 84 and on the companion ramming mix, Permanente 165. Principal sales offices: *Chemical Division*, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California. First National Tower, Akron 8, Ohio.

Kaiser Chemicals

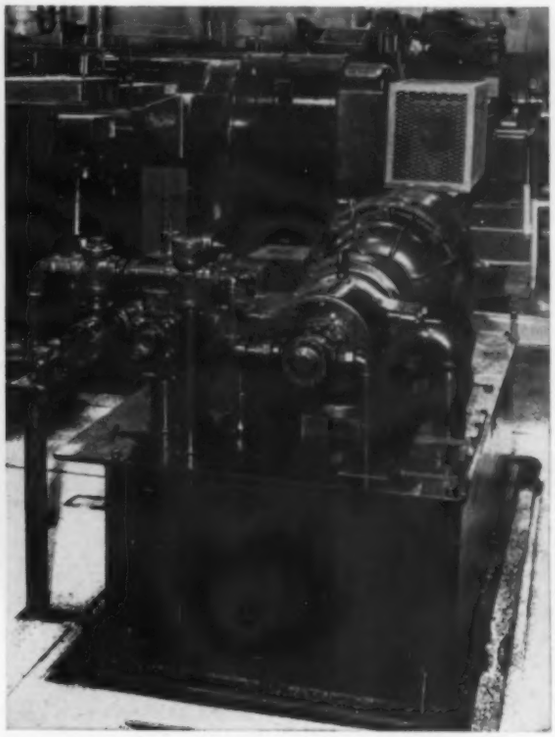
Pioneers in Modern Basic Refractories

Basic Refractory Brick and Ramming Materials • Dolomite • Magnesia • Magnesite • Alumina • Periclase

At UNITED STATES STEEL



Coil cradle on United States Steel Company's Irvin Works Three-Stand Cold Reduction Mill. Marvel Synclinal Filters are a part of the mill's main hydraulic system which operates this cradle as well as other hydraulic machines.



Hydraulic pump and tank on the recoiler hydraulic system of United States Steel Company's Gary Sheet and Tin Mill's Continuous Galvanizing Line. A Marvel Synclinal Filter is installed inside the tank on the suction line.

and with Hundreds of Others

MARVEL SYNCLINAL FILTERS

PROTECT HYDRAULIC EQUIPMENT

IN 1951 ALONE OVER 30,000 MARVEL SYNCLINAL FILTERS have been specified for installation on all types of hydraulic and oil recirculating equipment. In the plants of America's industrial giants as well as in the plants of smaller businesses, Marvel Synclinal Filters are doing a job protecting machines and increasing production. They are proving their superiority in the one real test — on the job. Records show Marvel Synclinal Filters operating longer between cleanings, requiring less attention, cutting down time, and in short, achieving more production with less maintenance. Not only plant operators, but also over 270 manufacturers of machines have recognized the superiority of Marvel Synclinal Filters and now install them as original equipment.

★

WATER FILTERS In response to the great demand we have designed both our sump and line models for use in all water filtering applications.

SUMP TYPE (Cutaway) LINE TYPE (Cutaway)

A SIZE FOR EVERY NEED in filtering non-corrosive liquids in hydraulic and low pressure systems. Sump and line type models available in capacities from 5 to 100 g.p.m. and in mesh sizes from 30 to 200. All models may be quickly disassembled, cleaned and reassembled on the spot by any workman. Line types operate in any position and are easily serviced without disturbing pipe connections.

Write for Complete Engineering Data — Specify Oil or Water

Meets J. I. C. Standards

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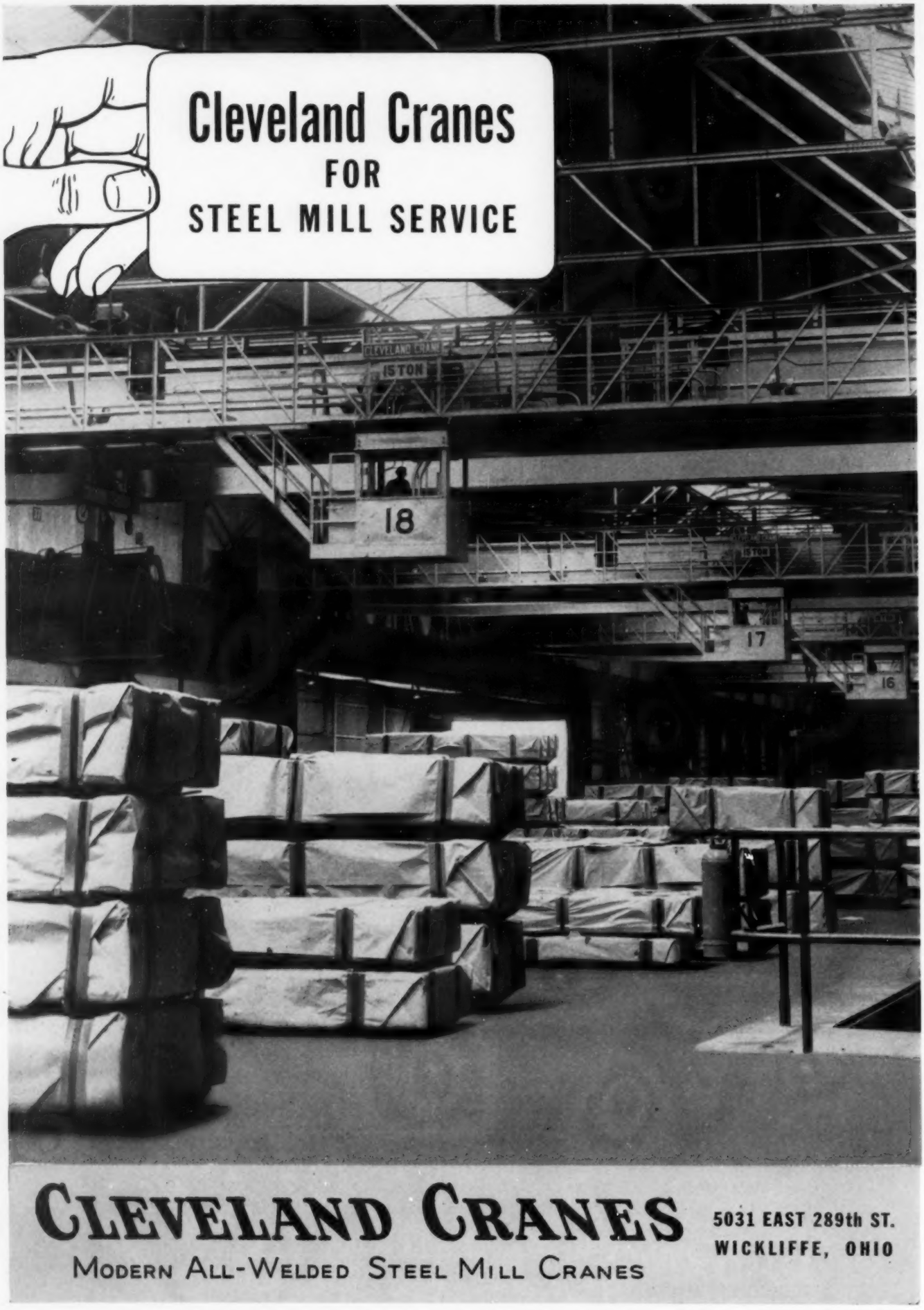
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"THERE is no statute that expressly authorizes the president to take possession of property as he did here. Nor is there any act of Congress to which our attention has been directed from which such a power can fairly be implied."

Never have we been so glad to have made a bad guess. Perhaps it's just a pessimistic streak in our nature, but every time we looked at the make-up of our Supreme Court, it seemed to spell "administration." With a respectful tip of our hat, our apologies to the court.

Philip Murray called out the steelworkers and asked for "collective bargaining conferences . . . . looking toward . . . . a contract firmly based on the recommendations of the Wage Stabilization Board." And there's the nigger in the woodpile. Thus far, there has been little or no bargaining, but rather a stubborn insistance on original requests, bulwarked by understandings with administration stalwarts. If this dispute is to be settled it must be through a "three-way stretch" — government, management and union must each give to effect a satisfactory compromise.

▲

HIGHLIGHTING the administration's stand in the steel fracas was Alben W. Barkley's statement: "It is as un-American for any group or any interest to defy or disregard a verdict of a government agency set up to settle these matters as it is to defy a verdict in court."

And Maurice Tobin, secretary of labor, said he made no pretense at being impartial in the steel dispute but sided wholeheartedly with the union. This same discerning individual, remember, told the Hod Carriers union that President Truman had led the United States to the "highest moral standards ever shown by any nation."

And Nathan Feinsinger, whose Wage Stabilization Board started it all, says that elimination of the board or limitation of its powers would result in chaos.

▲

SMALL comfort, perhaps, but the steel industry has some company. Administration bureaucrats are criticizing Congress almost as much as they have the industry.

▲

SPEAKING at the dinner of the annual meeting of the American Iron and Steel Institute, Dr. Clarence Manion, dean of Notre Dame's law college said: "Government grows at the expense of personal liberty. As personal liberty disappears, the sense of personal moral responsibility disappears with it . . . . The long arm of this completely un-American bureaucracy must be amputated at its source by the surgical operation of an informed and patriotic public opinion . . . . We can deflate big government by: 1. Demanding that governmental deficit spending be outlawed; 2. Demanding a permanent ceiling on federal taxes; 3. Resisting and reducing every federal appropriation for any and every purpose."

Another AISI speaker, William M. Akin, of Laclede Steel Co., said: "I wonder what the judgment of our successors will be 30 years from now . . . . Maybe as they sweat out some of the longer bond maturities they will wonder why we spent $2 where $1 might have done most of the work . . . . It is just possible that we've been a little bit over-engineered as well as over-built."

▲

CHARITABLE fund raising has become big business. Some 33,000 organizations are on the deductible charitable list of the Internal Revenue Department. During 1951 charitable donations totaled $4,200,000,000, of which about $2,000,000,000 went to religious causes. Approximately 1500 community chests collected $240,000,000, while about $77,000,000 went to the Red Cross, $33,000,000 to infantile paralysis work, and $15,000,000 to the cancer fund.

▲

INCIDENTALLY, a principal target of charity fund raisers in general is the group earning $5000 or less per year. Although individual contributions from this group are small, sheer weight of numbers makes their total contribution most important.

Our taxation experts who keep trying to "soak the rich" might take a lesson.

▲

ONE of our correspondents speaks more than a grain of truth:

There, little luxury, don't you cry.
You'll be a necessity bye and bye.

▲

WE can't help but wonder what Patrick Henry, who made such a fuss about taxation without representation, would think about our present taxation with alleged representation.

It is interesting to note that in several cases, with increased taxes, total revenues actually decreased or at least failed to rise. This is true for the United States liquor excise tax, and Canada has a similar experience with its cigaret tax.

▲

IT is also interesting to note that although many business men complain bitterly about increased taxes, some of them, traveling on the theory of "get it while the getting's good," do not hesitate to increase prices. Perhaps these individuals have forgotten that American economy is built on mass production, with resultant savings clearing the way for still greater production. Perhaps they should be reminded that the law of diminishing returns is just as applicable in their business as it is in the case of the taxes mentioned above.

▲

SPEAKING of holding prices, the recent convention of the United Steel Workers raised their dues 50 per cent.

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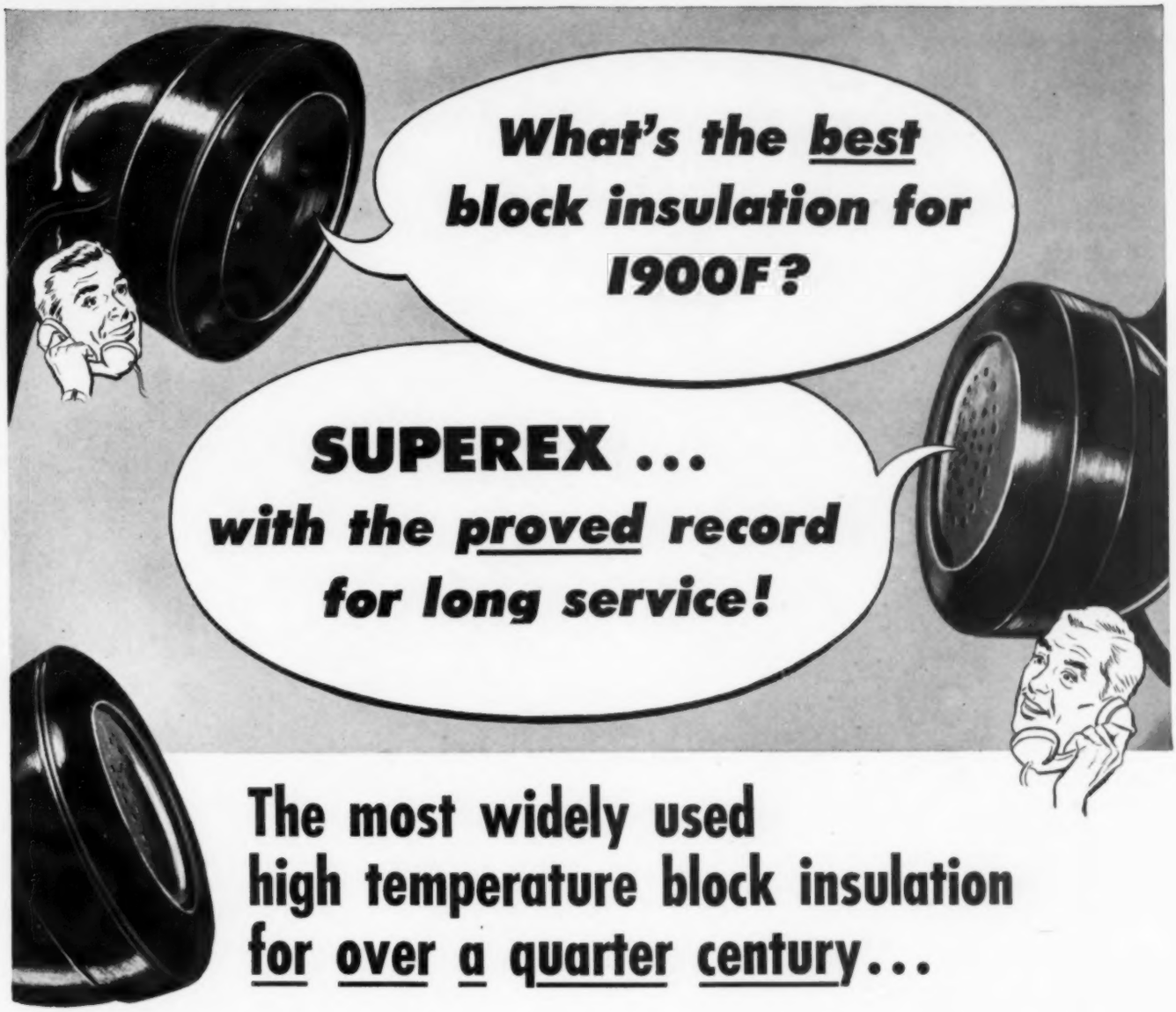

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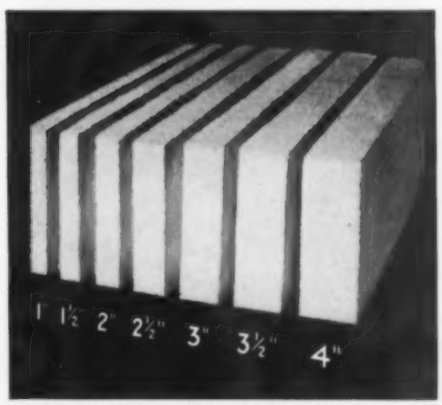

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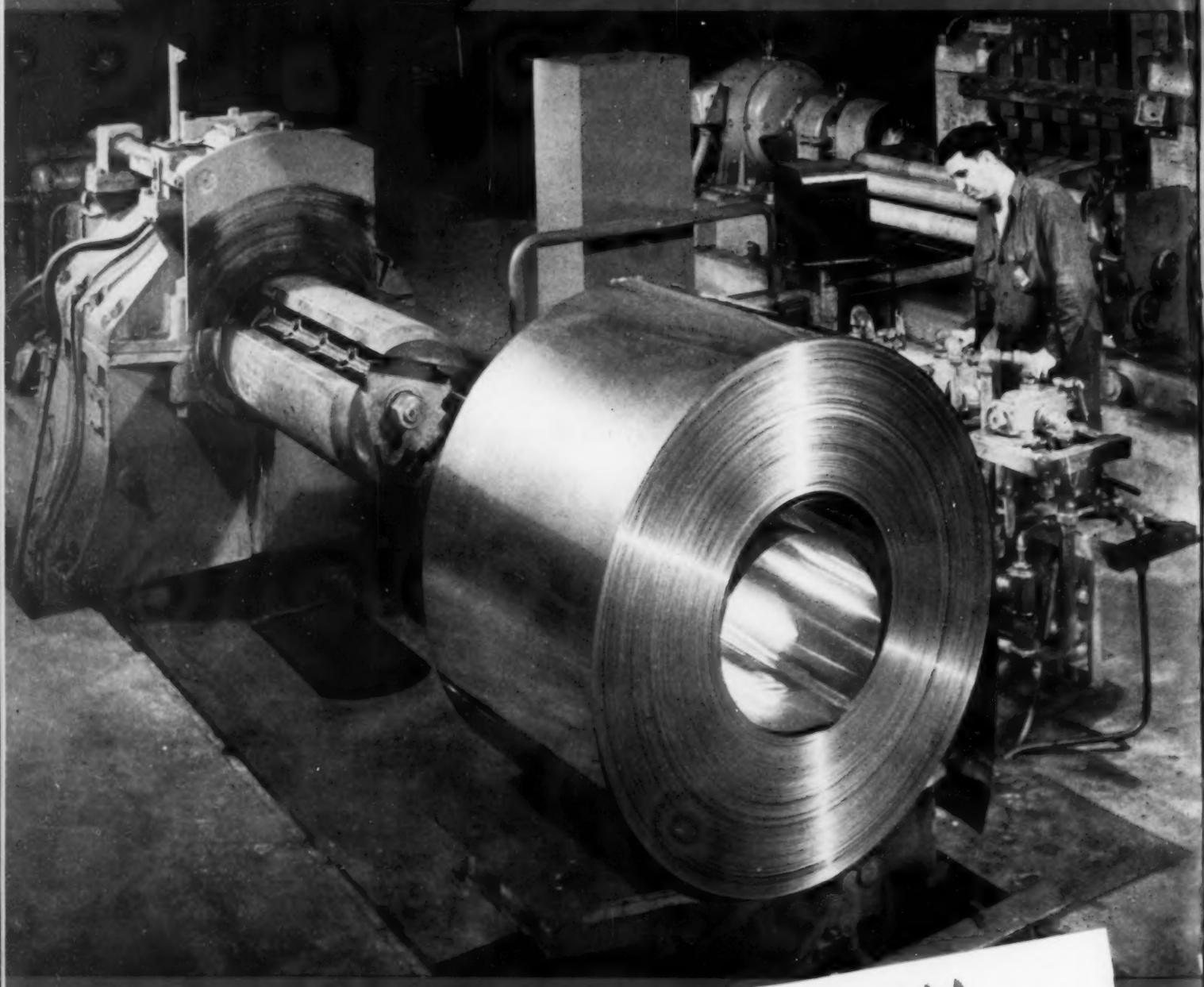

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Iron and Steel ENGINEER

JUNE, 1952 VOLUME XXIX NUMBER VI

In This Issue

Delivery of Torque to Rolls — By Louis Moses, Superintendent, Rail Mill and Roll Dept., Bethlehem Steel Co., Sparrows Point, Md..... 55

Long Range Look at Engineering Manpower — By H. N. Muller, Jr., Assistant to Vice President, Westinghouse Electric Corp., East Pittsburgh, Pa..... 66

Industrial Training for Professional Development — By Guy Kleis, Manager Educational Department, Westinghouse Electric Corp., East Pittsburgh, Pa..... 70

Temper Mill Symposium —

Temper Rolling — By J. F. Sellers, R. M. Peeples and A. C. Halter, Allis-Chalmers Manufacturing Co., Milwaukee, Wisc..... 76

Power Requirements — By Wm. P. Smith, General Electric Co., Schenectady, N. Y., and J. E. Butler, Electrical Engineer, Weirton Steel Co., Weirton, W. Va..... 87

Symposium on Soaking Pits —

At South Works — By G. Primm, Assistant to Division Superintendent, South Works, United States Steel Co., South Chicago, Ill..... 98

At Indiana Harbor Works, Youngstown Sheet & Tube Co. — By H. B. Helm, Fuel Engineer, Chicago District, Indiana Harbor Works, Youngstown Sheet & Tube Co., East Chicago, Ind..... 99

At Wisconsin Steel Works — By R. N. Powel, General Foreman Charge Heating, Wisconsin Steel Works, International Harvester Co., South Chicago, Ill..... 100

At Inland Steel Co., East Chicago, Ind. — By P. C. Singleton, Superintendent Combustion Dept., Inland Steel Co., East Chicago, Ind.. 101

New Tube Extrusion Process at Babcock & Wilcox Co...... 106

Steel and Industrial Relations Grow Together — By James K. Sutherland, General Manager, Steel Division, Ford Motor Company, Dearborn, Mich..... 111

Ore Bridge Span Uses Arc Welding for the First Time — By H. E. Cable, Welding Engineer..... 116

Facilities Streamlined in New Reliance Plant..... 122

Date-line Diary..... 131

Industry News..... 135

Personnel News..... 155

Equipment News..... 171

Index to Advertisers..... 199

Published Monthly by
ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING
PITTSBURGH 22, PENNSYLVANIA

Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expressions of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility.

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Indexed by Engineering Index and by Industrial Arts Index.

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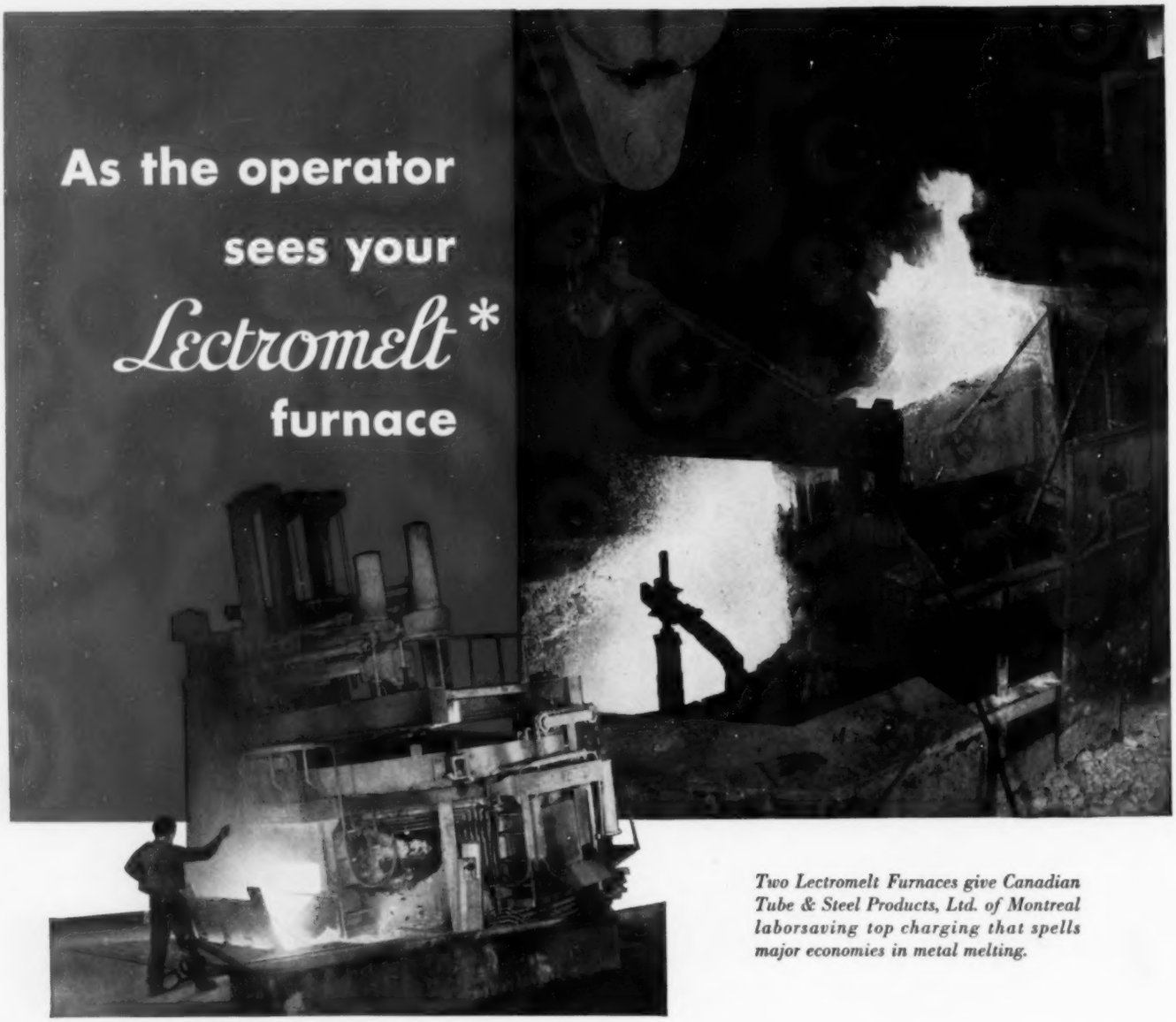

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WHEN YOU MELT... MOORE RAPID *Lectromelt*

Delivery of Torque to Rolls

By LOUIS MOSES
Superintendent, Rail Mill and Roll Dept.
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Sparrows Point, Md.

. . . . in spindle design, there is an unquestioned trend toward the more highly engineered connections . . . .

▲ ROLLING mill literature discloses the principles and designs of mill drives and their controls. It also contains descriptions of mill appliances designed to obtain the fullest benefits from the drives. Until comparatively recent years, the parts connecting the drives to rolls have been largely taken for granted. As a subject in themselves they have lain neglected and unstandardized. In many cases, particularly where troublesome wear occurs, resort is made to alloy materials and to hard facings. This paper examines those facets of design, construction and usage which are considered as being significant, with particular regard to small and medium-sized mills, and with a passing glance at some of the larger ones.

Mill builders, engineers and many operators vigorously oppose conventional type fittings between the pinions and rolls of a new mill. They recommend various alternatives designed for greater efficiency in the transmission of power and torque. They are convinced that the ordinary as-cast spindles and muff coupling boxes retard securing the advantages built into modern bearings, advanced housing construction and facilities for holding rolls in adjustment for long sustained periods. In correcting these conditions, the modern spindle also secures maximum effectiveness from the latest speed controls, eliminates backlash and reduces mill delays generally.

Other equally able and experienced operators are of the opinion that the refinements embodied in machined spindles are unnecessary insofar as estimates of benefits can be determined from the ones presently installed or otherwise offered. They feel that the simplest and least expensive spindle-box combinations are fully adequate.

It cannot be said that the advocates of the new types are merely beset with the idea that connections should follow the thinking of the age to utilize accurately machined parts, because these are so much more readily obtainable than in past years. Neither can we say that such designs have no merit in adding to operational betterments. It is equally erroneous to charge lack of progressiveness to those who disagree, for the latter are credited with splendid performances indeed in other phases of advanced mill operation and production.

The number of mills equipped with machined spindles and the length of time they have run do not compare with the more numerous mills which are conventionally fitted and have operated for many decades. It is just as difficult to compare the performance values of either

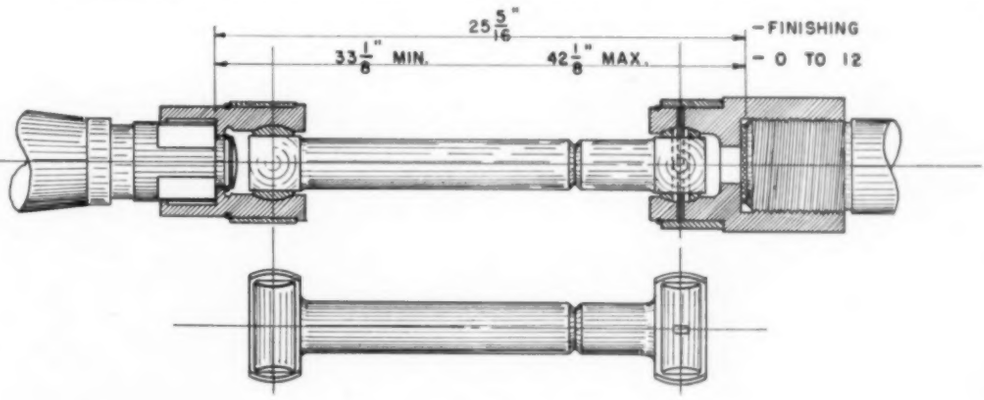


Figure 1 — The hammerhead spindle with its universal joint was designed for maximum flexibility.

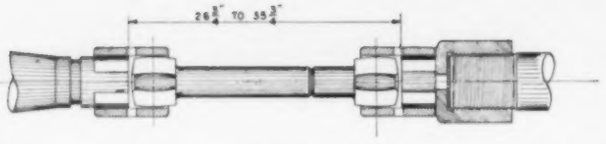


Figure 2 — This conventional type spindle has operated satisfactorily for many years in four-strand rod rolling.

new or old under the generally prevailing absence of adequate records. However, any piece of equipment which promises greater overall efficiency, as reflected in cost sheets, which in turn reflect tons per hour, must receive attention. Potential savings against unaccustomed higher billings for machined spindles may be in the form of smoother mill operations which permit the rollers to dismiss from mind any difficulties which are traceable to spindle influence on roll settings and to pay more attention to securing more tons per hour. As will be shown, the conventional type can sometimes be advantageously improved by relatively slight changes. Some of the earliest applications of machining created unnecessary stresses in the parts, which in turn prevented the fullest benefits of universal-joint action, such experience leading to later offerings which partially or wholly avoided the fault.

The charges leveled against conventional types can be directed to brand-new castings, to the more numerous cases of running the parts to virtual destruction and to equally faulty refacing by welding to restore profiles to original lines. While it is more generally the case than otherwise to note the truly remarkable manner in which inspection templets fit cast profiles of roll wobblers, spindles or cored-out boxes, there are lapses when the foundry producer places entire reliance upon the known amounts of annular or radial clearances. In the early days of the industry, when foundry techniques and molding materials may not have been as efficient as those of today, such instances undoubtedly added the word "Wobbler" to mill nomenclature, especially because of the action of the boxes when the mill was idled. Within the writer's time is the case of a mill supervisor arbitrarily ordering foundry alterations to provide additional clearances over an already made ample allowance to insure against difficulty during assembly or at roll-change time. A few months ago, at a mill, a conventional wobbler was observed to be completely ruined during its first run because the mill had not earlier thrown out a badly worn coupling box. The point made is that these extremes can just as well occur when linking foundry finish, or worn parts, with machining in the effort to obtain better alignments and equal distribution of torque in the driving parts. However these comments may be read, there must be recognition by everyone that leading mill builders particularly are making serious attempts to devise more efficient delivery of power to the rolls by such linkage and by other designs.

It is evident that when designing the spindle on Figure 1, for use with open top housings, the intent is to hinge the spindle around the pin at the pinion end and swinging it clear. Foundry accuracy was relied upon for box and roll wobbler profiling, to which was added a very close fit at the machined bore of the box with the finished outside diameter of the roll wobbler. A similar close fit of the bore in the partition of the box was also applied to a spool turned on the extreme roll end. The objective is clearly seen, the hammerhead spindle with its universal-joint should provide the fullest flexibility, the box is held in axial alignment as if integral with the roll, and it would be retained upon the wobbler by a snap ring. The slipper assembly is held with the outside sleeve and all parts have the usual clearances between the cored box interior and cast roll wobbler.

This spindle design was applied to the 16-in., 14-in., and 12-in. stands of a rod mill. It soon became evident that the confining action of the machined portions of the box was in conflict with inaccuracies of the cast wobblers. The jaws of the boxes developed spreading, making it difficult to remove the sleeve during roll-

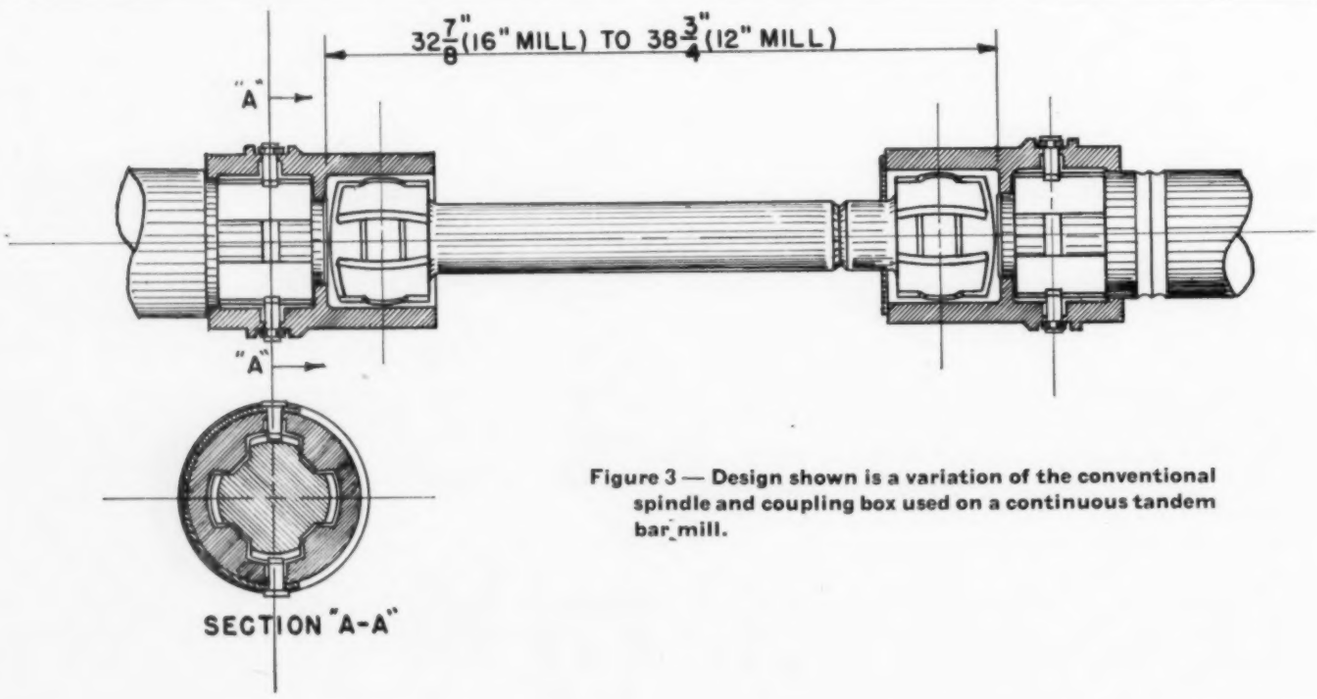


Figure 3 — Design shown is a variation of the conventional spindle and coupling box used on a continuous tandem bar mill.

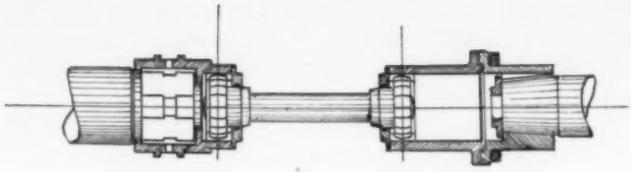


Figure 4 — Gear type spindle and box.

changing. This was highly time consuming and the spindles tended to jam.

The difficulty of making appraisals has been noted. These hammerhead spindles became so troublesome at Bethlehem Steel Co.'s Sparrow Point plant that they were replaced with conventional ones. Some ten years later a duplicate mill was installed elsewhere which when visited had been operating for several years with the identical types of spindle. Interest was aroused due to the above experience. Although the operators told of their complete satisfaction, it was suspected, when noting a weaving bearing, that they were having some trouble. Despite a full concurrence with the decision to employ conventional spindles at Sparrows Point, the use of hammerhead spindles by a third non-ferrous rolling mill cannot be discounted. Neither can the reliable information be overlooked that a foreign installed forerunner of all these mills has consistently and regularly used the hammerhead type since about 1935.

Figure 2 shows the displacing, conventional type spindles which over many years have performed admirably under the loads of four-strand rod rolling and the conditions given in Table I.

TABLE I

Pinion pitch, (in.)	Rpm	Maximum angularity, (degrees)	Total displacement, (sq in.)
16	13	1.25	4.28
		1.33	3.40
	to	1.33	2.32
		0.88	3.56
		1.00	2.04
	52	0.93	1.64
14	80	0.60	0.90
	to	0.55	0.72
	140	0.61	0.44

It should be noted that the designer has correctly curved the faces of the pods at the partially spherically shaped ends. In some other cases conceptions of the manner in which a spindle operates were naive indeed. This reference, and some are probably still in existence, applies to cases where the faces of the driving pods have been left straight and parallel to the axis. A ball-ended spindle has no more ability to handle torque under angularities than its pods permit and pod faces must be curved as well as the outside diameter. Every quadrant and all intervening points of rotation must be considered as shown in Figure 2.

Figure 3 shows a variation of the conventional spindle and coupling box applied to a tandem continuous bar mill. As in the case of the hammerhead spindle, there are two machined fits working in combination with foundry finish. The partition in the box does not permit the box to slide over the spindle. This partition is not practical with any except closed top housings or where mill construction has retractable pinion or roll housing stands. In such cases, the coupling boxes are keyed onto the pinions with the spindles remaining therein when changing rolls. The coupling boxes are placed on the roll wobblers beforehand and the spindles are guided into them by hand. This partition is intended as a face against which the spindles' ends may react, rendering it unnecessary to have separate pins or spreaders to hold the roll coupling boxes in place.

Another variation is a conventional spindle, also arranged with two machined fits. The four pods of the box within the spindle end are extended and bored to tolerance fits, which centers the box to the roll end button. The relative larger bore diameter and smaller root distance across the spindle flutes permit the box to slide over the spindle in the ordinary way. This variation made the operators seriously consider the adoption of the double-ended gear type because of difficulties at intermediate stands. However, a conventional and non-machined assembly is being experimented with as a solution, and is currently reported as overcoming the difficulty.

The pins are used to keep the box in a fixed position over the full length of the wobblers. It is understood that in one installation, the pin diameters originally provided required enlarging, showing that the stress which tends to pull off the boxes is considerable. Comment on the use of pins inserted in the manner shown is withheld pending longer experience, but some operators believe that the long used ordinary wooden stretcher-block is a better means for separating the boxes. A constant maintenance problem on most mills is created because the ends become battered and are used too long, allowing boxes to partially work off, wearing the ends of wobblers to a taper. The stretchers are sometimes made of metal instead of the more common oak. However, pins are almost universally used to hold couplings from pulling off the rolls at strip mills.

Figure 4 illustrates the gear type spindle with its box. This is growing in popularity and is installed in a number of recently built mills. It meets all specifications governing successful spindle operation, particularly in regard to minimum annular clearances as well as ability to deliver torque under ordinary spindle angularities. In this illustration there are also two bores in the box, to center it and hold it in axial alignment. The flexibility permitted by the spherical-faced gears doubtless takes care of any differences in the driving pods. The parts are made of specified materials which are carefully heat treated for long life. This particular construction is used on the 10-in. finishing stands of several rod mills where, with crescent flutes, it is pronounced as highly satisfactory, with maintenance costs reportedly low.

The hammerhead type shown in Figure 1 was also originally installed on the 10-in. finishing stands at the Sparrows Point plant. The rolls running from some 650 to 1400 rpm presumably failed because the lubricants were thrown out by centrifugal force. Figure 5 shows the substitution made as used on the twin finishing trains (twelve stands in all). Spuds cut from scrap plate are welded onto lengths of 2½-in., XX pipe, with the pipe ends closed as a butress. A roller conceived the idea and made up the first ones. The arrangement has served for some twelve years without trouble and with

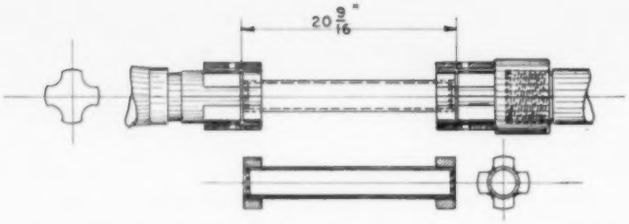


Figure 5 — This spindle design was developed by a roller and built out of pipe and scrap plate.

very little expense. It is a striking example of rugged simplicity and performs the same functions as the gear type under identical conditions of rod mill operation. Wooden spreaders separate the boxes. Spindle angularity never amounts to more than ¼ in. either way, which corresponds to 0.35 degree angularity.

Known as the Johnson type it is also installed with equal success on many of the stands of an older 10-in., 3-stand rod mill where it was adopted to eliminate difficulties with conventional spindles. With half of the stands so fitted, it is intended to serve all ten of them. These run at speeds ranging from about 240 rpm to some 1200 rpm, and have a maximum spindle angularity of 0.84 degree.

A proposition to supplant these with the no less successful gear types would unquestionably be met with vigorous opposition, for there is no conclusive data on savings to be had, either directly or in operational results. Precisely for the same reason, the users of the gear type would resist recommendations to employ the Johnson type. There are many who favor the gear type due to the higher speeds provided on rod mills. To serve the higher speeds, it is understood that the gear type is being most favorably considered, in combination with the two-flat wobbler.

At the same time the users of the above simple spindle accord high and enthusiastic praise for a gear-type spindle shown in Figure 6. Necessarily short it would be a very difficult position for conventional designs, but it has given no concern in over fourteen years of four stranding operations. The top spindle shown with bolted flanges is used only for registering the rolled ribs on concrete reinforcing bar; when bars or rods are rolled, the spindle is the same as the bottom. During its use since 1937, repairs have been nil at the gear end and just ordinary at the roll ends. There is no trouble with lubrication or with angles of 0.35 degree maximum. It demonstrates the advantages of minimum annular clearance through elimination of chattering which often occurs when deformed sections are rolled. Other applications elsewhere employ gears at both ends of the spindle.

The following specifications and comments cover the majority of functions. All must be considered, whether the mill is large or small. However, some items can be discounted for an individual roll-stand position. For example, lubrication is not a prime necessity on a slow-running roughing stand where water is sufficient for the purpose with the conventional types; roll pounding or backlash are not vital matters at roughing or intermediate positions, etc.

1. *Roll changing* — As little time as possible should be required in handling connections on or off the roll. Balky or close-tolerance fits, elaborate fastening or tricky manipulations require the attention of the mill crew which is better applied to readying the mill otherwise for quick starting. Of the two major housing types, the open tops require pulled-back and slipped-on box movements. In the case of closed tops, the roll must be hung in a level position for insertion of roll wobbler or fish-tail into the end of the spindle. Wrenching the roll into registry with box profiles or inching the drive (a consideration on large mills) should be kept at a minimum and the least number of tools should be used.

2. *Angularity* — Angularity is caused by the prevalent differences between fixed pitches of pinions and varying diameter rolls, together with the vertical location of the pass line. It is the main reason for obtaining the closest possible approach to a universal-joint action and it becomes of cumulatively greater importance as speeds are advanced or torque is increased. Wobbler profiles must not lock at any quadrant.

3. *End-thrust, chattering, waviness* — A simple experiment demonstrates that a roll moves endwise in a direction away from that end to which a rotating force is applied. Using machine-tool precision in the set-up, a roll is centered with the roll-grinder headstock and the necks free to float in their bearings. When revolving the roll, it travels toward the tail-stock. Again, in a roll

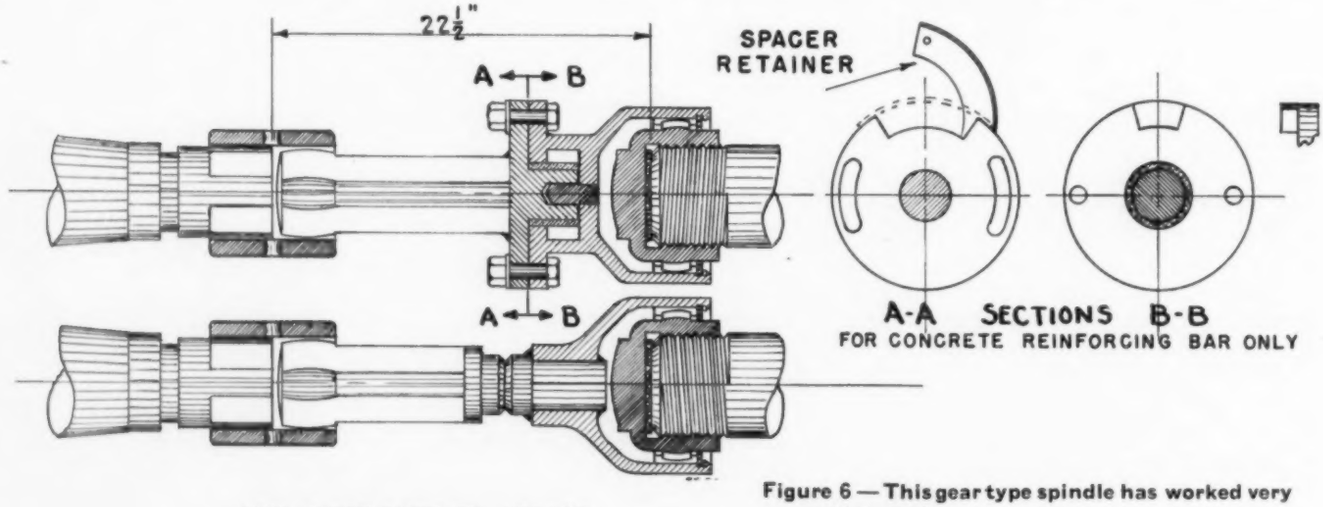


Figure 6 — This gear type spindle has worked very satisfactorily.

lathe, a driving spindle, as inserted into the face-plate driver, crawls away from the face plate when power is applied. The same actions of spindle and roll occur with any design employed to rotate the roll, especially under the multiplied greater torques and speeds of the mill, and regardless of extraneous influences of tapered wear of driving parts or angularity between pinions and rolls. With the rolls firmly held in the housings, the reaction of the box is to crawl the spindle.

With exception of the rolling of irregular sections, the balanced work applied to rolling geometric sections does not create side thrust or roll crossing. Conventional spindles and box assemblies unquestionably cause thrust, as evidenced by correction of former serious difficulties through the ability of roller bearing end-thrust resistors to hold it. The rolling of irregularly shaped sections, diagonal grooving, etc., are often perplexing and time-consuming because of roll actions undoubtedly caused by spindle end-thrust. Sufficient clearance, with insurance against shouldering, must be provided to permit the spindle to float. On the other extreme, an excessive amount of end-play clearance destroys the continuity of a longitudinal spline effect. Thrust is particularly troublesome on roll stands arranged axially and driven from one roll stand to another. Huge amounts of power are consumed by friction on large mills through screwing-up end bearing faces to hold rolls against thrust.

Shadows on the surface of hot rolled products persist after pickling, plating or painting. Markings are not measurable as gage variations, and are often manifested as shadings of color. They are sometimes the result of minute, but otherwise appreciable, thrusting of the spindles and boxes which cause one roll to cross its mate with resulting intermittent rupturing of the scaled surface. With pronounced cases of wavy edged bars or wash board delivery, a change to fresh box or spindle will remedy the condition.

4. *Balanced application of torque* — Again going to the grass roots for analogy, it is well known that an extraordinarily accurate job of cylindrical grinding on a long, slender shaft must employ a driving dog having two driving faces placed diametrically opposite one another. Experienced operators use feeler gages to make certain that the same rotating pressures are exerted on each face. If a dog having but one face were applied, that is, with only one point of the circumference doing the driving, a "weaving" finish would result.

The driving of rolls, spindles or boxes from one flute, or with a preponderance of torque application on one side, is similarly faulty if a smooth action is to be conferred to the roll. This specification becomes the main target of the exponents of machined spindles. However, combining foundry cast profiles with tightly fitting machined bores can cause such one sided applications.

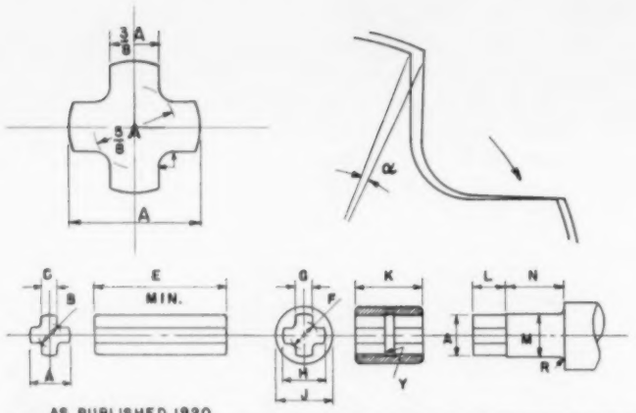
5. *Accommodate high speed and lubrication* — This specification is mentioned elsewhere in connection with rod mill finishing and centrifugal force throwing out the lubricant. Along with developments to the heavy duty spindles serving 5000 fpm cold-reducing strip mills, a successful spindle will be evolved for even faster rod mills. The angularity of spindles under such speeds may not exceed 0.40 degree, as an estimate. The cored holes in the rim of the box shown in Figure 5 (which is used at 4200 fpm) are hopefully intended to allow some water to reach the driving faces of the pods and carry away frictional heat. Realistically viewed, it is certain that very little or no water enters at such speeds. One user of machined spindles reported that lubrication was the chief worry at the fast end of a rod mill, the dilution of lubricant with water being a factor. On slower-speed mills and on large mills, some water may and does make its way between the flute faces, and boxes have been burned up when a stoppage of water occurred.

6. *Roll pounding* — An unbalanced assembly creates an effect just as surely as does an eccentrically turned or "eggy" roll body, as varying gages are produced at each revolution of the roll. At speeds of 800 rpm or more, unbalanced conditions are always intensified by centrifugal action. Effects are most pronounced at the finishing pass where the product is measured as a matter of course. It is, however, equally damaging when occurring in the leader, or in adjacent stands where gaging is not possible. These variations affect the finished gage in no less degree, and the puzzled roller generally blames the difficulty on poor roll turning.

7. *Annular clearance, backlash, contact faces* — The amount of annular clearance allowed has the greatest single influence on backlash. The function of roller and anti-friction bearing linings is to minimize drag on the necks so that only a little pressure is required to keep the driving faces of wobblers and boxes in contact when the mill is empty, and running at full speed. This causes the rapidly revolving small rolls, as well as the slower, but heavier rolls, to develop sufficient inertia to over-run the annular clearance. The end of an entering bar may momentarily brake the roll almost to a stop, until the drive catches up. Within the system of spindles and boxes for a stand on continuous mills, or in one driven from stand to stand, the accumulation in all the joints amounts to the total backlash which, with conventional designs, is generally around twelve and sometimes reaches twenty degrees of rotation at the roll, using brand-new parts. This pause between the roll stoppage and the picking up of full load can largely nullify the split-second timing which the electrical engineers build into controls for the purpose of handling no-load under speed to full-load under speed. It has often been suspected of causing cobbles when there is no visible evidence to account for a stuck front end.

Our drawings seldom exhibit the relations of contacting pod faces when the latter are transmitting torque, and such relationship is more often than not taken for granted as being all that it should be. Sketches of the three types mostly used in the industry will follow in detail and show the characteristic relationship of box pods to the roll or to the spindle. A given pod is generally used on both the roll and the spindle, with the coring of the box common to both. Some recent mills employ coupling boxes in which one end is cored to work with a profile on the spindle and a coring at the other end to fit a roll wobbler of different profiling. Annular clearances are variously affected by some of these modifications, becoming weighted factors when attempts are made to increase the wear resistance of the pod faces.

8. *Machining* — Among the other objectives of *machined spindles* is that of conferring long tenures of usefulness. A distinction is drawn when considering the machining of *roll wobblers*. Designs must not require expensive machining costs because of repetitive replace-



AS PUBLISHED 1920

MILL SIZE IN.	A IN.	B IN.	C IN.	E IN.	F IN.	G IN.	H IN.	J IN.	K IN.	L IN.	M IN.	N IN.	R IN.	α DEG.
18	10 1/2	6 9/16	3 15/16	28	6 7/8	4 1/8	10 13/16	14	14	7	11 1/2	12	1	2.2
16	9 1/2	5 15/16	3 9/16	26	6 1/4	3 3/4	9 13/16	13	13	6 1/2	10	11	15/16	2.5
14	8 1/4	5 3/16	3 1/16	24	5 1/2	3 1/4	8 9/16	11 1/4	12	6	9	10	7/8	2.8
12	7	4 3/8	2 5/8	22	4 3/8	2 13/16	7 1/4	9 1/2	11	5 1/4	7 1/2	9	13/16	3.3
10	6	3 3/4	2 1/4	20	4	2 7/16	6 1/4	8 1/4	10	4 3/4	6 1/4	8	11/16	3.8
9	5 1/4	3 3/16	2	18	3 7/16	2 3/16	5 1/2	7 1/4	9	4 1/4	5 1/2	7 1/2	5/8	4.4
8	4 3/4	3	1 3/4	16	3 1/4	1 15/16	5	6 1/2	8	4	5	7	5/8	4.9

AREA = .6 A^2 SECTION MODULUS FOR TORSION = .125 A^3

Figure 7 — Shown here is representative practice applied mostly to Belgian type mills during the 1920's.

ments alone which can run up the costs of routine purchases. Machined wobblers, however, are a necessity on many rolls, regardless of spindle types used, and especially with the smaller ones having long necks where cast wobblers cannot be produced concentrically with the condensed rim of the roll body.

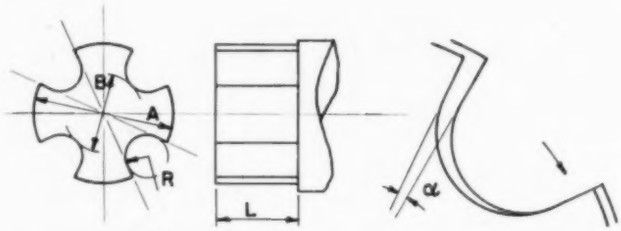
A procedure when selecting a conventional wobbler for a new mill is to compare with existing mills and make duplicates to satisfy the amount of work to be performed at known roll diameters, etc. This is a safe enough method, but improvements would languish if it were always followed. Investigation of types made during the preparation of this paper shows the constant attempts, over many years, by mill builders and plant engineers to improve spindle construction, with the pace accelerated today. It has made use of the great accumulation of applied experience, references and formulae to determine power requirements for the performance of given amounts of work under defined circumstances. It would be an understatement to say that the latter is a far-reaching subject so it is left here with those talented engineering investigators who evolve such calculations. However, the comparative section modulus for torsion of each of several selected wobbler shapes is investigated by graphical method. Except for being interesting, the application of the property for selection of a wobbler type is of little practical value, because the large factor of safety always allowed swallows up the rather slight relative differences among the several profiles. Comparisons of reentrant angles as stress raisers, and the streamlining of others to better resist the imposed stress are important factors. The dimensional proportionings and comments on three cruciform patterns follow:

Parallel Faced Pods

Figure 7 is lifted from a bulletin published about 1920. It depicts representative practices of the time, with many examples being in use today. These particular proportions were mostly applied to the Belgian type mills constructed by the mill builder, the industry drawing heavily on it or making adaptations. The parallel faces of the profiles permit the box pods to slide crosswise on the roll pods, a close approximation to a universal joint.

Radially Faced Pods

Figure 8 illustrates this type as designed and installed on a large group of merchant mills about 1924, and is still in use today. Radial faces have considerable appeal when viewed solely from the standpoint of ability to transmit torque around a common center of rotation. A prominent application of radial faces is found on the clutches of shears. When engaged, the power is transmitted concentrically with the shaft centers. However, mill spindles do not operate along such a center line assumed to extend through both the pinions and the rolls.



1924

ROLL BODY DIAM. IN.	A IN.	B IN.	R IN.	L IN.	α DEG.	AREA FLUTE SQ. IN.	AREA WOBBLER SQ. IN.
18	11 1/8	6 1/2	1 21/32	6 5/8	4.6	6.25	72.2
14	8 5/8	5	1 9/32	5 3/8	3.9	3.85	43.0
12 & 13	7 3/8	4 5/16	1 1/8	4 3/4	6.9	2.77	31.6
10	6 3/16	3 5/8	15/16	4 1/8	5.9	1.97	22.6
8	4 15/16	2 7/8	3/4	3 1/2	6.9	1.22	14.3

B = 0.583A R = 0.15A AREA = 0.581 A^2

SECTION MODULUS FOR TORSION = .126 A^3

Figure 8 — This spindle design has radially faced pods and was installed on a large number of merchant mills.

In contrast to the parallel faces, permitting side slippage without locking, the radial profiles always hug a common center. The respective narrow-to-wide dimensions of the pods, or lobes, have resemblance to a Maltese cross, preventing any sidewise movement across one of the two axes because of the virtual wedging action. In this respect, the profile does not fill the functions of a universal-joint. An example of the grave effects on a 44-in. roll will be stated later on.

These radial patterns were deliberately lifted about 1926, for a rod mill, and used up to quite recently. Demands for increased efficiency bring details to light which have heretofore been obscure. While no criticism had been raised all the while, a vibration was noticed at the finishing end of the mill about a year after the operation had been changed from two to three-strand operations. The action of the finishing rolls, running at around 1200 rpm, was compared with that of the rolls on a neighboring mill with the same diameters, similar spindle angularities, rolling two strands, revolving at 1400 rpm, but having crescent-shaped flutes in the

wobblers. By changing the radial pattern to crescents, the vibration was eliminated. Vibration generally indicates faulty working of the parts with resulting effects, depending upon the severity of the case. While the above effect occurred at the higher speeds, the question arises if it would not extend to radial-faced pods acting in the same way at slower speeds with higher torque.

In addition to their long use on the group of mills for which they were designed, radial flutes also proved successful since 1927 on an extremely hard worked continuous skelp mill, the finishing rolls of which run at 385 rpm.

Crescent Flutes

Figure 9 shows a wobbler-type used on continuous bar and rod mills for over fifty years. Proven over the years and widely distributed, it still is an efficient profile today. Note comments made under radial faced wobblers on the relative effects of this crescent type on smooth transmission of torque. Compared with those on Figures 7 and 8 the root dimension at flute bottoms is respectively 7 and 13 per cent larger. Some experienced engineers use this dimension solely for computing torsional strength against anticipated torques. With maximum stresses exerted on the extreme outside fibres, the matter of stress raisers within the profile is also of importance, this crescent fluting profiling being an almost complete approach to the absence of reentrant angles. Many rolls are necessarily made with cast rather than cut wobblers. Crescent profiles allow for the sweep cutter action of a horizontal boring or milling machine, the most economical method of machining short of the flat-faced wobbler. This is referred to under machining specifications. Its strength is illustrated by the 7⅝-in. wobbler applied by a courageous mill builder to a 16-in. roll pulling a 4.28 sq in. total rolling load. This diameter of crescent fluted wobblers compares with 9½-in. wobblers with parallel faced pods driving 16-in. rolls, and 8⅝-in. diam wobblers for the radial pod type applied to 14-in. rolls. The tabulations on Figure 9 are accumulations of known applications throughout the industry and as such are not provided by a mill builder.

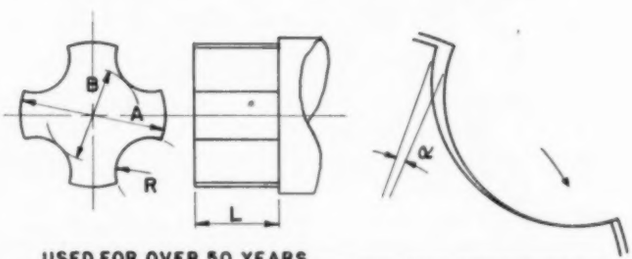
Figure 10 shows a plate mill roll wobbler, driven by the top vibrating spindle, the shape of which resembles a Maltese cross. Despite the ball end on the spindle, the coupling-box tends to incline from the horizontal. The revolving assembly developed a locking action which prevented the respective faces of the box and roll pods from sliding. This occurred particularly at the quadrant shown. If the wobbler pod was not literally pulled out as indicated by the broken line, the corners would come out of the mill in a badly spalled condition. The relative states of wear and resulting clearances would dictate when this would occur, new boxes and new rolls making the worst combination. Substitution of the conventional parallel faced pods eliminated the trouble.

Figure 11 is an example of erroneous reasoning as applied to the profiling of a coupling box on a 114-in. plate mill. Figure 11a shows the box pods in contact with the outside corners of the roll pods, similar to those on Figure 7. At the time the pod wear was considered to be excessive. When wear reached a certain stage, the friction brakes could not readily restrain backlash as the emerging plates left the rolls. To reduce wear, the box coring was made so that the pods therein would make contact along the full height of the roll pods, as in Figure 11b. However, in suggesting this Maltese-cross effect, the increased amount of annular clearance was lost sight of. It soon became evident that the cure was worse than the disease because initially new boxes caused as much backlash as did the original ones when worn. The type coring shown in Figure 11a was therefore reestablished. Successful with the formerly used chilled-iron and grain materials, there has been some difficulty with spalled wobblers on double-poured, high-nickel rolls. This material is more brittle, probably because of uncompleted flushing of the alloy iron from wobbler corners. To meet this current problem, the pod corners are beveled to receive the shock loads about half an inch within the wobbler's outside circumference.

A similar case is shown in Figure 12. Parallel-faced pods are retained in the coupling box, but the faces of the roll pods are inclined from the parallel sufficiently to make a full height contact when under load. This provides the sought-for long-lasting properties, but it makes the 21-in. continuous mill, on which it is applied, very noisy because of backlash.

The fully machined roll wobbler, with two flat faces shown in Figure 13, will be found almost universally used on the industry's hot-strip and cold-reducing mills. A fully machined coupling connects the roll and spindle. This coupling has replaceable inserts working against the wobbler faces through which wear is taken up when necessary to within the rather close tolerances allowed to prevent backlash or slapping. At the opposite end of the coupling, a spade driver, termed the fishtail, engages

Figure 9 — Wobbler type spindle shown has been used on continuous bar and rod mills for over fifty years.



USED FOR OVER 50 YEARS

ROLL BODY DIAM. IN.	A IN.	B IN.	R IN.	L IN.	α DEG.	AREA FLUTE SQ.IN.	AREA WOBBLER SQ. IN.
24	13 3/4	9 5/32	3 7/16	8	3.2	9.42	110.8
18	11	7 1/4	2 3/4	6 1/2	3.5	5.11	74.6
16	8 1/8	5 7/16	2	5 5/8	3.4	3.11	39.41
16	7 5/8	5 5/64	1 29/32	4 7/8	2.8	2.91	34.0
14	6 1/2	4 21/64	1 5/8	4 3/8	3.5	2.15	24.6
12	7	4 21/32	1 3/4	4	3.2	2.44	28.7
12	6 7/8	4 9/16	1 3/4	5	2.2*	2.37	27.64
12	5 5/16	3 35/64	1 5/16	3 3/4	4.5	1.38	16.6
10	5 1/2	3 21/32	1 3/8	4	3.8	1.46	17.92
10	4 15/16	3 19/64	1 1/4	3 1/2	3.2	1.16	14.48
10	6 3/16	4 1/8	1 1/2	4 1/8	3.3	1.78	22.9
10	6 3/16	4 1/8	1 1/2	4 3/4	2.3*	1.78	22.9

B = 2/3 A R = 1/4 A AREA = 0.589A^2

SECTION MODULUS FOR TORSION = .125A^3

* USED WITH GEAR TYPE SPINDLE

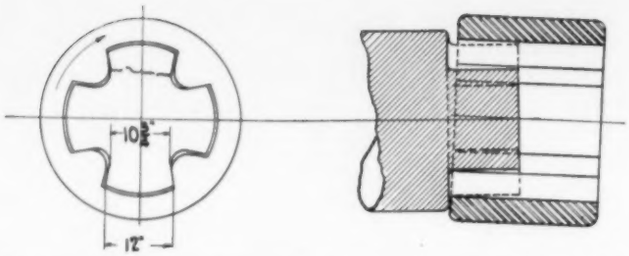


Figure 10 — This plate mill roll wobbler is driven by a spindle whose shape resembles a Maltese cross.

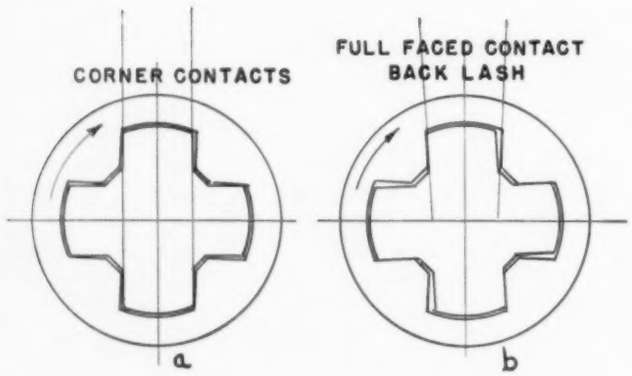
with the flat interior faces of the spindle segments, the assembly at this end forming a universal-joint. The spindle is connected to the drive in the same manner to obtain full flexibility under angularity. Because of the numerous modifications and proportionings employed, a correspondingly large number of sketches would be required to show representative designs. The latter are more or less in a state of flux by reason of accumulated experience, along with the ever higher speeds of the cold mills, so that almost any selected example is likely to become obsolete a few years hence.

The specification concerning rapid roll changing is particularly important on mills, the construction of which involves the highest skill of engineering and the mechanical arts, to achieve the closest possible alignment throughout the length of the train, closed top housings at exact right-angles, close dimensional tolerances of bearings and rolls, etc. An uninformed observer of the operation of changing work rolls could easily conclude that the apparently "slap dash" method employed does not imply such accuracy, yet it most certainly does due to the ingenious and sturdily constructed spindles and roll wobblers.

In considering the wobbler with the two flat faces the first reaction of those wholly accustomed to the conventional types might be that it is not as strong as the conventional. This idea is dispelled when noting that the two-fluted wobbler, Figure 14, failed to pull the heavy roughing stand load on a large hot-strip mill. The flat-faced type was substituted and has run for some twelve years on this difficult position with complete success.

From a builder of such mills it is learned that an average dimension across the flats in some thirty examples amounts to 73.7 per cent of the outside diameter. At this proportion, the section modulus for

Figure 11 — Design here shown did not work too satisfactorily.



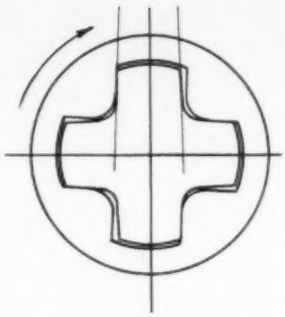


Figure 12 — Design shown here worked very satisfactorily, but has been noisy because of backlash.

torsion amounts to 0.109 times the cube of the diameter, which is apparently lower than the above stated values for conventional wobblers. Another builder advises that his calculations for torsional moduli of conventional wobbler shapes are based upon the root diameter at the flute bottoms, disregarding the lobes. He thus finds that the torsional strength of this flat-faced wobbler, when proportioned at 70 per cent of its diameter, is greater than the conventional ones. Regardless of any outcome of an extended study of sectional properties, it may all be summed up by observing that there is a complete absence of stress-raising reentrant angles in the profile, which accounts for the improved performance over the two-fluted wobbler, and no less over the cruciform types.

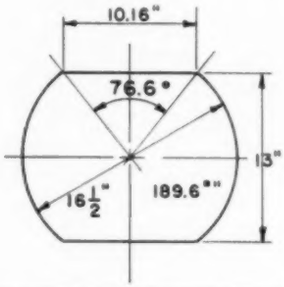


Figure 13 — The fully machined roll wobbler shown with two flat faces is used almost universally on hot strip and cold reducing mills.

Aside from the strip mills mentioned, this wobbler is now applied to the industry's latest installation of mills, including several units for breaking down blooms to billets, etc. It is also being used at the higher-speed stands of a rod mill. It is hoped that those whose knowledge extends to the latest applications will describe them in full.

Up to this point, the three-pod wobbler has not been mentioned. Throughout all of the foregoing, the requisite of obtaining a universal-joint action has been stressed. The three-pod type does not give such action at any point over the 360 degrees of rotation. Nevertheless, and despite the design not having this property, it is one of the oldest types and has been used continuously over the years in the operation of both small and

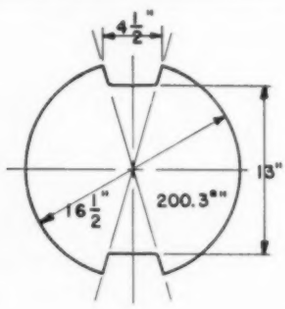


Figure 14 — Wobbler shown was not able to handle the roughing stand load on a hot strip mill.

large rolling mills. Some users vigorously assert its superiority over the cruciform type. In fact, one whose numerous mills embrace both types, claims that it is far the best because of its much fewer failures. A search would probably bring out as many instances of equalled low maintenance among the other types, however.

Its main characteristic can be compared to that of a three-legged stool, the feet of which always rest evenly upon a floor, no matter how uneven. Regardless of inaccuracies in coring or casting, such a coupling box always divides the total torque equally among the contacting faces of the three pods. While this discounts concentric running of the profile as a whole, it fully satisfies the specification demanding equal application of load around the entire circumference of a wobbler or a spindle.

In modern installations, the three-pod type is discounted in favor of others having universal-joint actions, and it is considered to be a faulty means for the smoothest transmission under the usual conditions of spindle angularity.

In the foregoing, an attempt is made to fairly exhibit the faults, if any; the merits if so indicated; the occasional obscured reasons for operating characteristics; etc. of spindles. There will be more or less substantiation of the views of respective adherents and an equal opposition to some stated views. With it all, there is an unquestioned trend toward the more highly engineered connections. These, machined from selected materials and heat treated for strength and wear resistance, will most probably provide long life, attendant trouble-free delivery of power and torque, and the intangible but none the less actual economies to be had by a mill's overall performance. It is believed that the future will see more and more applications of machined connections. It is also hoped that some principle, herein stated, will induce thought leading to less expensive corrections of conventional types where difficulties may be present.

DISCUSSION

PRESENTED BY

A. F. EISEL, Roll Designer, United Engineering & Foundry Co., Pittsburgh, Pa.

LOUIS MOSES, Superintendent, Rail Mill and Roll Dept., Bethlehem Steel Co., Sparrows Point, Md.

WILLIAM A. MILLER, Superintendent, Rolling Mills, John A. Roebling's and Sons Co., Roebling, N. J.

A. F. Eisel: I would like to add several remarks and explanations pertaining to the application of roll wabblers with two flat faces for successfully delivering torque through spindles to rolls.

First, refer to Mr. Moses' remarks relative to many mills using the old conventional four or three pod wabblers and spindles without any trouble. This is no doubt true and is due to the use of long spindles and balled wabblers all operating at moderate speeds.

Roll wabbler and coupling box performance depends primarily on angularity of spindles, clearance in the couplings and operating speeds. Angularity is governed by spindle length, which is determined by space available between roll stand, pinion stand and mill drive, also the varying roll diameter with respect to fixed pitch of pinions. Many mills having excessive spindle angularity, resort to the use of balled wabblers on both roll and spindle, thus minimizing wear and coupling box breakage.

Many of the troubles encountered in the delivery of torque to rolls are never heard of unless they seriously interfere with production or show excessive costs. All one needs to do in observing mills with successful delivery of torque to rolls is to note the absence of noisy backlash, broken coupling boxes and roll necks, worn roll or spindle pods.

As Mr. Moses also mentioned, I believe the flat-faced wabbler is here to stay, and is being universally adopted on new installations. It is very readily cast and machined on any type roll, while the fluted types are more difficult to cast and machine. Many of the smaller sizes require oversize casting to obtain sound metal, thus necessitating extra machining. Balling the wabblers on rolls also requires an additional machine tool setup.

Full face contact on multiple faced wabbler pods is never really maintained and eventually wears itself down to the two faced contact. This is best noted by uneven wear of the roll pods and very often results in premature scrapping of rolls.

Further to Mr. Moses' remarks regarding split-second timing, built into controls for handling no-load under speed to full-load under speed, it seems rather false economy to build mills with precision radial and end thrust bearings without a precision connection to rolls.

Momentary roll stoppage due to excessive coupling clearance is in my opinion no longer a theory. This theory has been verified by the following actual experience. On a recent continuous strip mill installation rolling narrow widths to about 0.032 in. minimum gage, finishing at 2200 fpm, conventional four pod wabblers were supplied with the usual clearance. Fully enclosed water lubricated bearings with extra large roll necks were specified. Initial operations disclosed terrific backlash and excessive cobbling between the higher speed finishing stands. Rapid conversion to the close fitting two-faced wabbler with universal couplings eliminated the trouble.

Confirming Mr. Moses' statement, I believe the flat-faced wabbler, Figure 13, came into its inception about 1942 due to an accident, and had its initial application on a 98-in. hot strip mill. The wabbler as shown in Figure 14 was in use, and a heavy reduction was necessary in one of the roughing stands to finish the required gage. The excessive load literally sheared the corners off the pods, resulting in the emergency changeover to the flat-faced type requiring less machine time. This type was thus adopted on the later installations of hot or cold strip mills, blooming or slabbing mills.

It was also adopted on the entire mill installation at Lorain. Refer to "Recent Developments in Blooming, Bar and Billet Mills," Iron and Steel Engineer, August 1950.

Other installations operating or in process of design include: rod, bar and merchant mills, having 16, 14, 12 or 10-in. roll stands. Initial applications were confined to mills with closed top housing requiring the removal

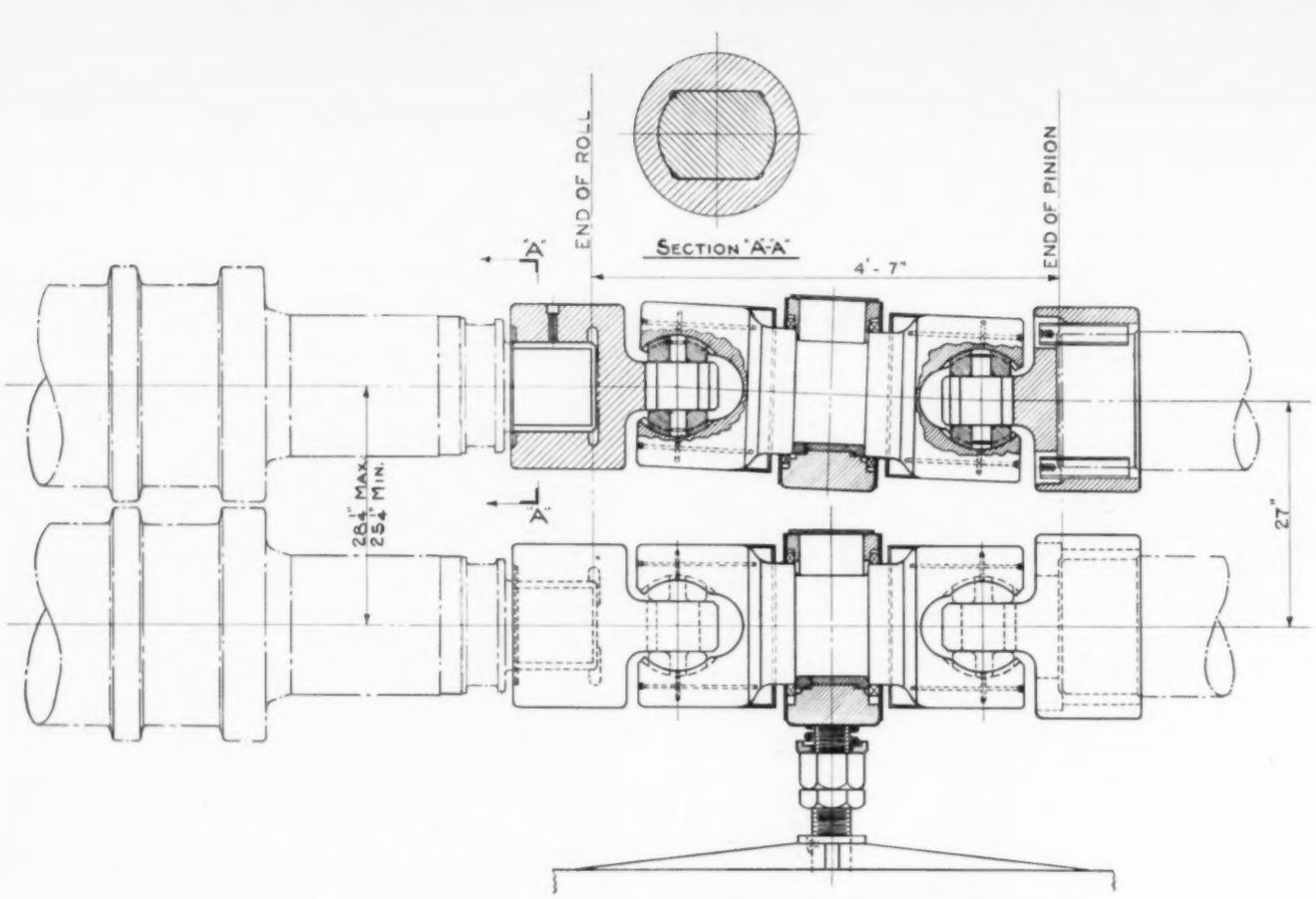
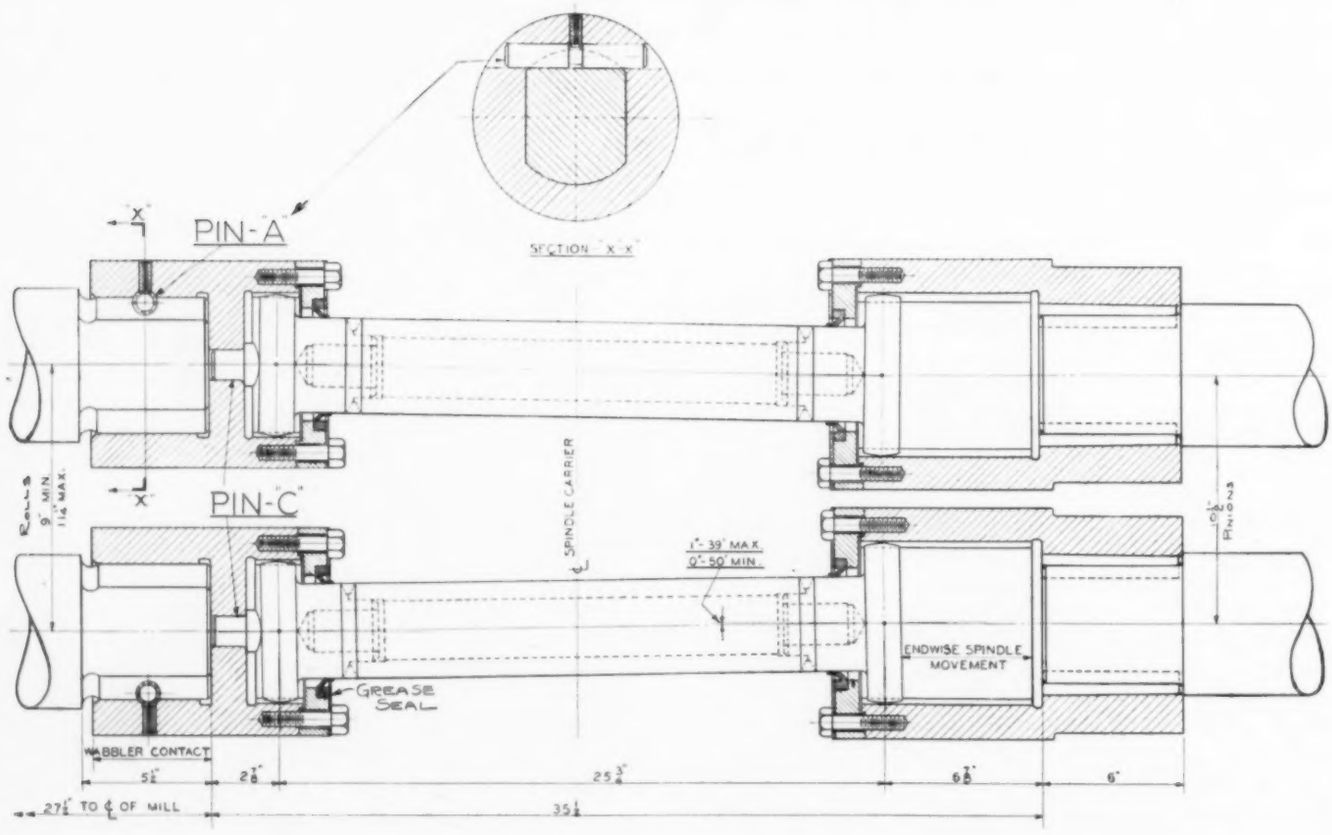


Figure 15 — Layout shows horizontal mill spindle arrangement on a 28 x 48-in. mill.

Figure 16 — Spindle arrangement on 10-in., 2-high mill.



of rolls endwise. This application is illustrated in Figure 15 and shows the spade type coupling box as the connection between flat-faced roll wabbler and universal spindle. Clearance inside the box all around wabbler was established at about 1/64 in. and to my knowledge has not been changed.

Member: What about backlash on roll wabbler?"

A. F. Eisel: Very little backlash or wear is noted with this amount of clearance. More clearance may be desirable from the standpoint of faster roll changing operations. Increased clearance will cause faster wear and more backlash and it thus becomes the problem of the operator to determine the lesser of the two evils. Close cooperation between the operating department supervision and the mill builder usually results in a satisfactory agreement on this point.

Recent applications to rod, bar and merchant mills as previously mentioned is illustrated in Figure 16. This shows a gear type coupling box as the connection between flat-faced roll wabbler and gear type spindle, and permits removal of rolls through open top housings. Spindles are of tubular construction with tapered cut gear teeth stub ends welded in place.

Please note that coupling boxes used in connection with flat-faced wabblers do not, nor can they take any angularity. The close clearances provided for smooth and positive delivery of torque to rolls do not permit any angularity. All angularity is taken up by either the universal or gear type spindle and coupling.

Disconnecting the coupling box for removal of the rolls is performed by first removing pin "A" shown in Section XX, Figure 16. Spindle with roll coupling is then moved endwise toward pinions, through a distance approximately 1 to 1½ in. greater than roll wabbler and coupling box contact. Refer to notations in Figure 16 (Endwise Spindle Movement and Wabbler Contact).

Pinion end coupling boxes are securely keyed to pinions and spindle pinion remains therein while changing rolls. A partition in the roll end coupling box with renewable ball end thrust pin "C" prevents excessive vibration. The taper of the pinion teeth on spindle ends takes up spindle angularity which is usually held to a maximum of 2 degrees. Proper lubrication is provided to both coupling and spindle gear teeth and retained by suitable oil seals.

Member: What about the combination mills like the one going in at Algoma? Will they use a different type wabbler on that?

A. F. Eisel: I do not know what type of wabbler they will use but I see no reason why the flat faced one cannot be used.

Member: Is the length longer?

A. F. Eisel: Length of wabbler need not be any longer than fluted type.

Member Do you still keep the partition in?

A. F. Eisel: Partition is maintained in the roll end coupling box, and left out of pinion end box.

Louis Moses: Are they used with spindles?

A. F. Eisel: The flat-faced wabbler may be used with either gear-type or universal-type spindles and coupling boxes.

Member: What is the highest speed they have been running flat-faced wabblers?

A. F. Eisel: We anticipate speeds up to 5000 fpm.

Louis Moses: Is this on a 10-in. mill?

A. F. Eisel: Yes; flat-faced wabbler merely acts as a driver and takes no angularity.

Wm. A. Miller: I was particularly curious as to the speed it is possible to attain with a coupling to fit the flat-faced wobbler type roll end for rolling small rods at high speed.

A. F. Eisel: There seems to be no limit on the speed. It all depends on the connections between the drive there.

WANTED!

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Long Range Look at ENGINEERING MANPOWER

By H. N. MULLER, JR.
Assistant to Vice President
Westinghouse Electric Corp.
East Pittsburgh, Pa.

. . . . engineers promise to be in very short supply for years to come . . . . as a result maximum utilization must be made of their capabilities . . . .

▲ THE subject of engineering manpower has been discussed a number of times in the past year. Last winter and spring it was an easy subject to talk about, principally because the management groups in industry in America had not started to seriously think about their technical manpower supply, the recruitment of replacements and additions, or about the inroads made on their force in being by the military and by piracy of professional people within industry itself.

Now the situation is very different. In the last six or eight months there has been more said about the supply of scientists and engineers to American industry than in the previous decade. Thus, to be helpful to one's contemporaries dictates that we dig a lot deeper, stay under a lot longer, and come up with something considerably more profound.

First I want to cite a few statistics that may be new, but which are important statistics on the engineering manpower supply. These figures are from our colleges that American industry must count on to build and continue the technical machine in our country.

In 1949 and 1950, the colleges in this country graduated about 50,000 bachelor-level engineers each year. There was then much said about an oversupply. But it did not exist. Most graduates had jobs before or very shortly after graduation.

This year (1951) 38,000 men received engineering degrees. Next year (1952) the number will be 26,000. In 1953 it will be 20,000. In 1954 it shrinks to somewhere between 12 and 17 thousand. These figures assume that none of the men are going to be claimed by the military when they graduate, an assumption that obviously is preposterous.

What does that mean? Well, the most conservative estimate of technical requirements made in the last year says that we need 30,000 graduate engineers a year for industry, not taking into account the military —and not taking into account industrial and research expansion for defense purposes. This is a serious situation.

During this current year, in 1951, we know from surveys that we could have assimilated 80,000 graduate engineers exclusive of the military. We graduated 38,000 and just about one-half of those graduates were committed to the military at the time they left the campus.

This is a dangerously serious situation. It is serious to our company because we need engineers. It is far more serious to the national security.

For the first time in the history of our great country we are faced with the possibility of total war against a foe of vastly superior numbers of people. That is a new concept to Americans and a lot of our people have not yet realized the grave implications. If war should come against that kind of an adversary, can we win it? I think the answer is yes, but only if we are superior technologically. The equation of arms times men must be balanced or overbalanced to win, and we know that we cannot match our potential foe in numbers of men. Therefore, technology is an absolute keystone to national security.

The beautiful ideal that in a democratic nation everybody is exactly equal and must be treated equally must be only an ideal. We like to think of Mrs. Jones' boy and Mrs. Murphy's boy as being equal and treated the same, with their first duty to their country being to bear arms. Today that must be no more than an ideal if we wish to protect our national security.

We are short of engineers and scientists. And we know that through 1955 their number will be increasingly short in supply. Is there anything that we can do about it? I have talked to those who say no. They are wrong. They are accepting the path of least resistance.

There are some things we can do. It is true we cannot lick the depression birth rate. For the next five years there will be too few boys reaching military age, or employment age, to meet our national manpower needs. There is nothing we can do about that. Yet there are a number of things we can immediately do about the technical manpower supply.

First and foremost, I am going to mention proper orientation and training of young graduates into industry—putting round pegs into round holes—avoiding the losses that occur through misplacement of young men in the industry—putting men in jobs where they are happy and motivated to develop rapidly to do the maximum for you or the military, the government, or whoever employs them.

Men trained and placed in jobs where they can grow rapidly and contribute most can have more effect, than any other single measure, of increasing our numbers. It is one way to help young engineers do more quicker. You know that in our organization training has occupied a prominent position for a long time and we can attest to the effectiveness of good training in getting men to be really productive quickly.

What are some of the other things that can be done today? One of them is providing opportunities for continued education. Education is a journey, not a destination. Nothing enables a man to accomplish the maximum amount on his job better than good learning habits. The morale of a budding professional man is high if his boss encourages him and helps him to supplement his college training by further work, evening classes or guided self-study.

In Pittsburgh I know that many of you know about the graduate work programs that we and a number of the steel companies sponsor in cooperation with the University of Pittsburgh. Right now there are hundreds of our engineers taking both technical and nontechnical courses that enable them to broaden the base upon which they build. These young engineers will grow faster, they will be more effective, and these results are very quickly seen by management.

Speaking from the standpoint of the national picture, these graduate study programs, such as your people and ours enjoy here in Pittsburgh, are not always possible because of geography, isolated location, or other factors. But if supervisory people encourage their young men to continue their education, even in healthy self-improvement programs, they will develop professional competence faster.

Before the supply and demand of engineering people in America gets further out of balance, *make sure your engineers are doing engineering.* Does that sound trite? Then take a look at your organization. If you find graduate engineers in jobs that can be filled by supporting-level people, rectify that situation quickly. There is more than one thing wrong with underutilization of graduate engineers.

First, of course, it aggravates this whole situation we are talking about. It uses up men with bare minimum of four or five years of education in jobs that can be filled by technicians with relatively little training.

Second, we found out a long time ago that it is the expensive way to get the job done. Using engineers to do your drafting, to do your testing, to do the work of a laboratory technician, etc., is an enonomic waste to your company. I am not inferring that work assignments on the drafting board, on the test floor, or in the laboratory, are not very valuable training. They are very good training for a lot of good jobs, but unless the engineer is of very limited potential for some reason, then the supporting-level jobs can be done cheaper and with more honest satisfaction by technicians.

Third, young men that have a high ultimate potential will only develop at a maximum rate if they are in jobs that are a challenge to their ability, a challenge to their experience, so that while the young man can keep his head above water it is not without some struggle. If you are careful to place these young men in jobs where continued challenge meets them day to day, you are going to be amazed to see how fast they grow to meet opportunities that they then are able to see.

I have not so far touched on the problems posed to employers of engineers by the expanding military forces, and I want to do so just very briefly, because that could be another talk in itself. I think most of you

Figure 1 — The Westinghouse Educational Center, where the classroom portion of the Westinghouse Graduate Student Training Program is carried on. The Educational Department staff is also housed in this building. The "Center" is the home base for all trainees, although about two-thirds of their total training time is spent on actual work assignments.

recognize that manpower has to be shared with the military. The important point is to exercise judgment in determining who is to be shared, that is, where can each individual's contribution mean the most? We have adopted a policy of asking for deferments from Selective Service for only those people who can contribute the most, in our honest opinion, by remaining in industry. This includes all graduate engineers who are practicing engineering. Through continued and close contact with all branches of Selective Service, I am glad to say that losses to Selective Service have been exceedingly small. The reserves are another story. Over one-fourth of all the practicing engineers in America have reserve status of some kind. The rather

indiscriminate and very arbitrary recall of reservists has definitely worked hardship in some segments of our technical organization. We do not object to losing people when justified. We do object to losing valuable services of specialized personnel practicing their profession, and we strongly object to misuse of their talents in the military.

Almost any one of you can name individual cases of people you have known with highly valuable specialized skills who have been recalled to active duty to perform relatively menial chores. A group with whom I am working, the Engineering Manpower Commission of the Engineers Joint Council, has compiled a really alarmingly large list of such misuse of critical skills. Speaking both for industry and for this Engineering Manpower Commission, I wish to solicit your aid in calling these cases to the attention of responsible authorities anywhere and everywhere that you can. The country cannot afford misuse of professional talents.

I would like to touch very briefly on some of our company's longer range plans in this manpower shortage.

We have been analyzing our organization to determine where men without technical degrees can be used, and we are finding many situations where a technical degree, although desired, is not absolutely essential. Thus we are going to supply non-technical manpower for more jobs in the future.

Under the heading of long range plans, we include a new program of management development that is being introduced throughout our organization—in all of our plants, offices and headquarters functions. I will not go into detail except to state that it is one of the most comprehensive programs of management development in industry today. Our aim is to make our men of potential more effective in their jobs quicker and ready for increased responsibility sooner. To the extent that our educated manpower will thus be broader in gauge and greater in stature, it is going to have the effect of increasing our numbers.

Under long range plans for relieving the manpower shortage, I mention briefly the fact that we support a large number of scholarships, fellowships, professorships, and other aids to higher education. In recent months, some of our outstanding industrial leaders in America have made talks and published articles bringing to the attention of industry the responsibility they have to higher education. It is our opinion that if more of the employers of engineers in this country saw to it that financial aid was made available to worthy young men aspiring to professional education, a larger percentage of such people capable of assimilating that education would receive the opportunity to get it. We plan to continue those programs. We are sure they pay dividends to our industrial economy, and with long range perspective, it will certainly pay dividends to the organization that extends a helping hand.

Looking back into the nineteenth century in America, we see that the engineer occupied a semi-professional status. They were inventors and gadgeteers and they sometimes produced things on a modest scale. In the twentieth century the engineer assumed the role of expert on materials and processes and created a vastly complicated mass production society. Every time we have a significent technical innovation, the complication of our industrial society increases, so that a technical background becomes a requisite for more and more of the key jobs.

You might be interested to know that three years ago a survey of the 150 largest producing corporations in the United States showed that 50 had as their chief executive a graduate engineer. That number will increase every year, and you can depend on it. If we look back two decades, we would not have found a handful. It is the technological nature of our industrial society, its importance to our standard of living internally and to our national security that is responsible.

There is nothing we can do to greatly increase the number of engineers entering industry for the next five years. There are things that employers can do to augment the efficiency and utilization of our existing force. Among elements that I have mentioned are proper orientation and training of young graduates into industry, development of post-degree educational programs, full utilization of non-degree technicians at

Figure 2 — A view of the reading room at the "Center." In addition, there is a spacious and comfortable lobby-lounge located just off the auditorium.

supporting levels, thorough management development programs aimed toward advancement at maximum rate, and careful utilization of professional skills.

Now all we need in order to implement most of these measures is for management to be convinced that the measures will pay dividends, but it must be admitted that to effect maximum usage of engineering talent can be more difficult, but not impossible for enlightened management. It takes a firm hand to manipulate an established organization to redefine jobs, to reassign responsibilities, to assign to supporting levels trained technicians and relieve engineers of routine tasks. Some employers have done this, and as the pinch gets worse and worse others will be forced to act.

The outlook is not good, it is bleak, we are going to have a shortage for at least five years, because that is statistically proven. If the measures I have mentioned become regular operating practice with the majority of employers, then permanent good to the engineering profession can result.

DISCUSSION

PRESENTED BY

A. C. BROWN, JR., Regional Manager, Air Reduction Co., Pittsburgh, Pa.

H. N. MULLER, JR., Assistant to Vice President, Westinghouse Electric Corp., East Pittsburgh, Pa.

G. E. GRIMSHAW, Engineer, Johns-Manville Corp., Pittsburgh, Pa.

EMIL KERN, Vice President in Charge of Engineering, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

A. C. Brown, Jr.: Did I understand you to say that you had a management development program? Is that under way now or is it just proposed being started?

H. N. Muller, Jr.: Very much under way, and it is company-wide.

A. C. Brown, Jr.: Does that pick up where this training leaves off?

H. N. Muller, Jr.: Initially it picks up a few years beyond where the student program leaves off and we can recognize men as having management potential so that we can immediately do something about it. Speaking of the future, we will be very disappointed if it does not pick up just as student training leaves off, and with a lot of men with less formal education as well. Concerning the previous question, there is no time that we are not looking for men with technical (or other demonstrated ability) who have reason to be in our organization.

G. E. Grimshaw: You said there was a present shortage of engineers and in the future there is going to be a shortage of engineers, for at least the next five years. What is the explanation? Why is it?

H. N. Muller, Jr.: We conclude it purely from survey figures.

G. E. Grimshaw: My question really is, why is enrollment down?

H. N. Muller, Jr.: There are two factors. For one, the depression birth rate has reached us. We will have not more than 1,050,000 young men reaching age 18 per year. That is not enough for the job ahead.

Second, two years ago the Bureau of Labor Statistics took it upon themselves to make a survey of needs in careers, and published a book in which they concluded in engineering there was a vast oversupply. They did not check with some people in industry and in education who could have set them straight on misassumptions they made. They published a large wall chart that was sent to every high school principal and counselor in the United States that showed what an oversupply of engineers there would be.

You and I have met high school counselors. Every once in a while you meet one that knows engineering. Another knows law. That one knows medicine. Most of them do not know all the fields, of course. So here they have something authoritative, right out of Washington, and every youth that comes in and says, "I want to be an engineer," they answer by pointing to this big chart. They scared young men away from the engineering colleges in droves.

The Engineering Manpower Commission of our Engineers Joint Council that I mentioned has within the last six months persuaded the Bureau of Labor Statistics to send out a new wall chart completely reversing that stand. It will take another year for the effect to be complete. A third reason, of course, and this is regrettable but as far as I can see unpreventable, we had during the past year until June a situation of no defined manpower policy in the United States. We had a Selective Service Act of 1948 passed in peacetime, based on peacetime military, not geared to an international crisis, and it did not let the youth know where they stood. So the college students in droves quit education and enlisted last winter so they would not be foot soldiers.

These are three big reasons. One is birth rate, and it will be with us; two, national statistics put out on a misleading basis; and three, a very weak policy that lapped over into a year of emergency when it was made law for peacetime. There are other contributing factors of course. We have not all been the best salesmen for our profession.

Emil Kern: An important phase of our training program, as Mr. Muller has pointed out to you, is to fit the round peg in the round hole and the square peg in the square hole. We leave much up to our educational department or our employment department, but the phase of what to do with our students after they actually start to work I believe is something on which we have been falling down, and there is where we can really do a lot of good. I remember some years ago an alarming thing, a young friend of mine mentioned to me that he had to change his job because he had ceased growing, he did not get enough food for thought.

I live perhaps a little closer to Mr. Muller's organization than to any other large industrial enterprise in Pittsburgh, and I have always admired what they do for their men after they really start to work. This school of theirs is really something marvelous. I do remember some 25 years ago I attended some of their classes, and it always inspired me as something that was worthwhile and very farsighted.

That we are really facing a serious problem here was driven home to me on a recent trip to Europe. I happened to be in France, Switzerland, and Germany. Over there right now they are getting from us the best machinery we know how to produce, they will have better machinery than we have, the most of us anyway, the last word in design. And their countries are just full of technicians. France has, it seems to me many, many more trained technicians in jobs much lower than where we usually use college graduates. Germany of course always had many men with advanced degrees. I am a little concerned with this general situation in comparison with our conditions here.

I believe it would be a good point to take home with us that this problem is not one that ought to be left up to a specific department in our organization, that we all should contribute, we all have to help in order to really keep our country going.

Industrial Training for PROFESSIONAL DEVELOPMENT

By GUY KLEIS
Manager Educational Department
Westinghouse Electric Corp.
East Pittsburgh, Pa.

. . . . through training, the supply of engineers can be stretched, as the most effective use is made of the manpower available . . . .

▲ DURING the last few years, the words "professional development" have been heard frequently wherever engineers meet. There have been many papers on the subject, and the Engineers Council for Professional Development issued a very fine report in which they recommend certain programs to help guide the young engineer through his first five years in industry. It is through such efforts that industry, the colleges and the technical societies have become increasingly conscious of their responsibility to the young engineer as he starts his industrial career. Without help and encouragement, too many young engineering graduates tend to fall into a rut and spend their years as technicians, rather than getting into a personal improvement program to acquire truly professional status.

It is well known that most young engineering graduates have the capability of going ahead and really developing in the engineering profession—but they must be motivated to do so. The desire to learn, to launch a self-improvement program, is something that has to be instilled in a young man. He has this desire while he is in school. If he did not, he would be unable to complete the course and come out with a degree. But somehow when he gets his degree he is inclined to say, "Well, I've put in my four years, I've got a degree, now I'm going to cash in on my investment." He then feels that he can take a job and set the world on fire, without further "book larnin'."

Mr. Muller has pointed out in the previous paper[1] that "education is a journey, not a destination." The motivation to acquire knowledge in an orderly fashion is provided during college days by the promise of a college degree to successful students; but the motivation in industry is weak in comparison because the final reward is not as obvious. It appears then, that an effort should be made to preserve the young graduate's good study habits. An effective way to help accomplish this is to provide a smooth transition from academic life into industrial life. Here is where industrial training programs can be of vital service to engineers just entering the profession.

Freshly graduated engineers enter industry through two different routes: one by direct placement in a job, and two, through training programs. Through the first route, the graduate joins a company by going directly into a definite job where he starts producing the first day. His supervisor explains his duties, gives him necessary assistance, and before long he is right in the swing, grinding out answers and doing the assigned job. It would seem on the surface that this is the way to make a man productive in the shortest time, but let us consider the plight of this young fellow. He is just out of school, is making his debut in industry, and is probably leaving his home town. He reports in on his job, and meets his supervisor and the group of engineers with whom he will be immediately associated. As he goes about his tasks, he gets to know other people that are closely connected with this activity, but all of his working hours are tied up in this one particular field. He has little concept of the overall company operation, its organization, its broad policies, its products or services, and, above all, the channels of progress open to him. He has to dig out such information the hard way and probably makes embarrassing and costly mistakes in the process. He is rather lost in a strange world. He becomes a prize candidate for sliding into the rut which is often called "post-college slump." He just does not see where his opportunities are, because he does not know the industry, he does not know his company. As a result, he may lose the motivation to grow in his job, and may serve out his days as a forty-hour-a-week technician.

[1] "*Long Range Look at Engineering Manpower*," H. N. MULLER, JR., companion paper.

The man who comes in through the second route, an industrial training program, has an entirely different outlook on his industry and on the company for whom he works. He also arrives in a strange town, but enters a training program where he meets others who are in the same situation he is. They too are looking for friends. So immediately they band together and a very happy social life evolves in their new surroundings. The individual soon realizes that the company is investing a lot of money in him to fully acquaint him with all phases of their total operation. He sees that the company is interested in placing him in a job that best matches his interests and qualifications. He is fully cognizant of the career opportunities open to him and appreciates the vast amount of learning he still has ahead. He has the motivation to grow because he now sees the goal and knows the hurdles.

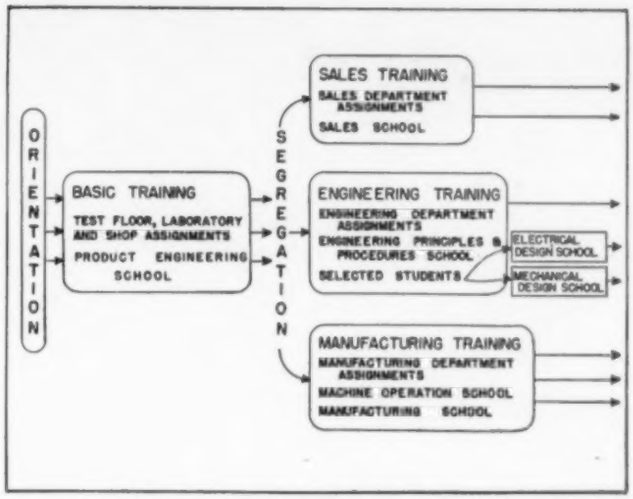


Figure 1 — Flow chart of the graduate student training course. The arrowheads on the extreme right indicate placement in a permanent job.

A TYPICAL INDUSTRIAL TRAINING PROGRAM

The organization with which the author is associated sponsors a comprehensive program of industrial orientation and training. It is this training course that will now be described, since it is quite typical of a well-rounded program for effectively launching the young graduate's career in industry. The author's close association with this specific training activity for a number of years will permit discussion backed by practice rather than theory alone.

This program has been in operation for over 50 years and nearly 20,000 young graduates have started their careers through this route. It is looked upon by management throughout the corporation (most of whom are products of the training course themselves) as the primary source of engineering and scientific personnel. Most department managers have occasioned emergency manpower situations wherein they were forced to hire men who had not had benefit of the training program. Such experiences have emphasized in reverse the many concrete values of training, and have solidified the company-wide backing of the training program. Wholehearted support by all management people, particularly top management, is an absolutely essential ingredient of any training program that is to be successful.

Each year the staff of the educational department recruits, trains and places all college-level manpower required by the entire corporation. Such requirements usually number between 500 and 1000 men per year, and are primarily engineers.

At the start of the recruiting program, specifications are set for the makeup of the manpower pool. These specifications are based on actual requirements as determined by a detailed company-wide survey. The recruiting director knows how many E.E.s, M.E.s, I.E.s, Chem.E.s, Physicists, Chemists, Metallurgists, etc., are needed; what percentages of the total must ultimately be placed in engineering jobs, manufacturing jobs and sales engineering jobs; how they will eventually disperse geographically throughout the country. It is the job of the recruiting director to procure top-level manpower from some 150 colleges to fully satisfy the pool specifications. The recruiting organization normally interviews eight to ten thousand graduates per year. Experienced interviewers can make a close estimate of the type of work each interviewee will ultimately select, thus enabling the director of recruiting to accumulate a properly balanced manpower pool.

Our training program assumes at the outset that the young graduate is unfamiliar with industry. The trainee makes no commitment as to the type of job he will ultimately fill. In fact, he is encouraged to investigate all opportunities so that when he does finally commit himself to a job, he is sure it is the right one.

The first phase of the program is called *basic training* and applies to all professional employees of the company regardless of ultimate job placement. The intent during this period is to provide enough background to enable the trainee to wisely select his major field of endeavor. At the conclusion of the 4½ month basic training period, each trainee segregates either to the engineering training program, the manufacturing training program, or the sales training program. Each of the 3 groups then receives special training for that particular phase of the company's operations and an attempt is made to find the best permanent job assignment for each individual trainee. This second phase of the program averages 4 to 5 months, making the total duration about 9 months (average).

To make the various phases of the training program more easily understandable, a flow chart showing course content is made a part of this paper. On the extreme left of this flow chart (Figure 1) a brief orientation period is indicated. The objective during this initial period is to acquaint the young graduate with his new situation. He is given a good general picture of the company he is entering, meets the people who will supervise his training, and is advised of what the training schedule will be, what is expected of him, what his ultimate opportunities are, and how he should conduct himself to derive the most benefit from the training program. This orientation is a conditioning period to prepare the trainee psychologically for the training course that lies ahead. The time allocated for this phase of the program is one week. During this time the student is also interviewed by his training counsellor to decide upon the first basic training assignment. All students are treated as individuals and the training is tailor-made to satisfy individual interests and abilities.

Figure 2 — A ramp to the stage door of the "Center" makes it possible to move in demonstration equipment and sizable display pieces. This is a tremendous aid in "getting across" the product story.

During the basic training phase, each student goes on three work assignments of one month each and in addition, participates in Product Engineering School, which is a six-weeks, full-time classroom activity. The work assignments are so arranged that each student will become well acquainted with three shop functions; namely, production, quality control and test. Each of these assignments will be in a different division of the company, so the student will become familiar with three separate product lines at the same time he is receiving his functional training.

The production assignment is designed to give the student first-hand knowledge of the works organization by bringing him into direct contact with the flow of an order through the shop. He is given a work assignment manual at the time of starting, which outlines the company shop organization and identifies that part of the organization with which he will be associated. Before being given another assignment, he is questioned by his training counsellor to determine what he has learned from the production assignment and whether he was given good training supervision by the organization he reported to. The supervisor to whom he reported also presents a written report giving his reactions to the man and indicating whether or not he would hire this man at the conclusion of training.

The quality control assignment gives the student a first-hand look at the multitude of steps that are necessary to control the quality of incoming materials, individual parts, sub-assemblies and final assemblies. A complete working knowledge of this operation is vital to the engineer, manufacturing man and salesman, alike.

The test floor assignment has a similar purpose. Here the young man actually assists in running tests on commercial equipment. He becomes familiar with the steps that are taken to assure that all equipment fully meets guaranteed performance specifications. He comes into contact with design engineers quite frequently while on the test floor and he actually works up test data into final form for the engineering department.

In addition to the three work assignments in the shop organization, the trainee attends Product Engineering School for a period of six weeks. He has already had work experience in three divisions of the corporation, but it is not economically practical to have him obtain like experience in the twenty-odd divisions that he has not visited. The Product Engineering School is an attempt to bring the rest of the operating divisions to the student. Here he gets the engineering background of the major products through lectures and discussion periods. He is graded on his oral presentations and is given an examination on each subject to see how he is grasping it. These are technical classes definitely at the graduate level and are led by recognized experts in each field covered. While the work is given during regular working hours, assignments are of a nature that require outside study. The student thus has an opportunity to apply his formal education toward an understanding of the latest design and development practices in industry. Here again, he is in daily contact with experienced training personnel with whom he can counsel concerning his studies and his future career opportunities in the company. To the training staff, the opportunity is provided to get a comparative rating of technical background, general ability and resourcefulness among the student group.

When the student has successfully participated in the assignments and classwork so far described, he has concluded the prescribed basic training program, and is ready to undertake additional temporary assignments, but of a more specialized nature and only in the field where he will find permanent placement. In other words, he is categorized, and this is the intended meaning of the word "segregation" on the flow chart. This function is delayed until completion of the basic training program so that the association with each man during training can be used to advantage. His various mental, physical and personal traits, ambitions and special abilities can be observed during the first several months of training, and hence the decision (made by training personnel and the student himself) as to preference of occupation will be well founded. It is a great advantage to both the student and the sponsoring company to delay specialization until the company and the trainee are mutually well acquainted. Many errors in job placement are thus avoided.

The last portion of the student's formal program is that of training for placement in his chosen field; usually engineering (which includes research, development, design and application), sales, or manufacturing activities. In each work assignment during this specialized training, the individual is a candidate for placement, and both he and the local management have this in mind as his tasks are undertaken. As during basic training, students are counselled before and after each assignment. Reports are received from the supervisor where the man was located, and this information is used as a guide in determining the nature of further assignments and final placement.

Each student receives classroom instruction during his specialized training. For those men segregated to

sales work, a concentrated sales engineering class is operated where equipment application, sales technique, company policies, etc., are taught. For manufacturing students a class is operated involving time study, manufacturing engineering, methods engineering, plant layout, quality control, and industrial relations. Similarly, for those men definitely pointed toward engineering placement, a class program on engineering principles and procedures is afforded. These schools serve to better prepare the student for his placement and to make him a productive technical employee as quickly as possible. A multitude of methods and techniques are thus taught collectively which anticipate hundreds of questions that otherwise must be answered individually after placement. The lost time and inefficiency thus prevented would be difficult to estimate.

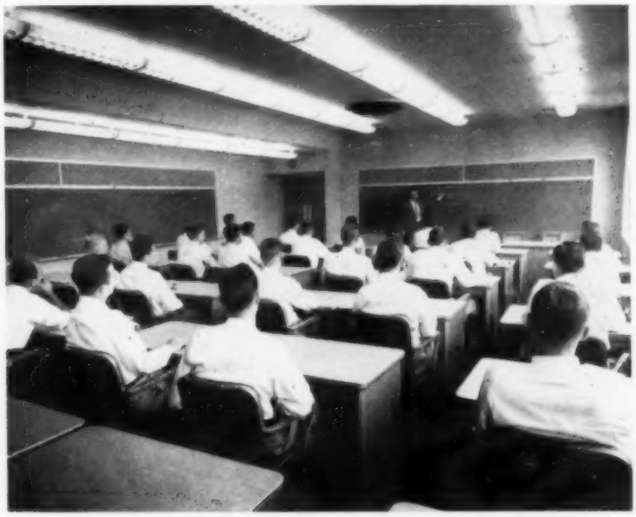
For certain engineering students who display unusual ability in the various fields of pure technics, there are provided two schools: the Electrical Design School and the Mechanical Design School. Outstanding technical students are selected for these schools by competitive examination and careful counselling. These schools embrace several courses in advanced fundamentals, definitely at the graduate level, and are designed specifically to tutor outstanding students in development and design techniques. It is the intent that through the use of expert instructors teaching small classes, each student will receive individual attention and his creative ability can be fostered in whatever line he shows talent. Satisfactory participation in this work requires a large amount of study at night as well as full-time effort in class during the regular working day. Credits affording a good start toward advanced degrees are given for successful completion of these schools.

The total time duration of the training program is quite flexible depending upon the type of job the trainee will enter and the length of time necessary to find the job that is just right for the individual. The elapsed time may be as little as six months or it may stretch out to a full year in some cases. As indicated earlier in this paper, the average at the present time is about nine months. The psychological effect created by allowing the trainee to play an important role in permanent job selection is tremendous. He fully realizes that during the basic training phase of the program he had the opportunity to learn and look over the entire company and the career opportunities it offers before he even had to select his major field. Then, after segregation, he had the opportunity to actually try out various types of jobs before making his final selection. The chances are extremely good that he will never worry too much about "greener pastures" because he had the opportunity to thoroughly look around before settling in his permanent job. The free-trial-offer assignment scheme is also a big advantage to individual department managers who are hiring men from the course. They can actually live with the man and observe his performance for a period of a month to six weeks before they have to commit themselves to hiring him.

The obvious question at this point probably is, "What happens to the culls?" The answer to this ties in very closely with the effectiveness of the recruiting organization. If their selection processes are good, very little weeding is necessary. Also, in a large organization that has a wide diversity in products and services, there is some satisfactory outlet for almost anyone in the student manpower pool. The annual loss before completion of the training program averages only 5 per cent. Of this number, the major portion terminates employment voluntarily for family or geographical reasons.

When the graduate student accepts a position in any one of the many technical departments of the company, his formal training is, of course, concluded. It would be shortsighted not to encourage further technical and business education, so a program of graduate study, arranged for maximum convenience and minimum expense, is provided at all locations where a sufficient concentration of technical talent exists. Hundreds of men, through participation in this program, have been granted advanced degrees from the cooperating universities. Courses are designed to provide the specialized education that the young engineer is now ready to accept. He has his fundamentals from undergraduate work, and his period of observation during industrial training to channelize his abilities, so now he can undertake specialized technics with some confidence that his studies are the correct subjects to develop his ability to best advantage.

Figure 3 — The six classrooms in the "Center" house the following activities: (1) Discussion sessions during Product Engineering School, (2) Engineering Principles & Procedures School, (3) Sales School, (4) Manufacturing School, (5) Electrical Design School, (6) Mechanical Design School, and (7) Graduate Study classes. The first six are daytime activities, while the seventh is an evening program in which the University of Pittsburgh cooperates.



OTHER APPROACHES TO INDUSTRIAL TRAINING

While the foregoing program appears to be ideal for the particular type and size company involved, it is recognized that certain variations are necessary for successful application in other companies. Small companies that employ only a few men a year obviously cannot "pool-hire" their men. The small employer should, therefore, use every possible device to make certain that he is hiring the right man for each job. Some small employers obtain excellent results by hiring students for the summer months between their junior and senior years on a temporary basis. This gives both

the employer and the student a chance to know each other and be sure of themselves before permanent employment after graduation.

It is easily recognized that the training program described above is a rather costly undertaking. Many of the smaller employers have been heard to say, "Sure, that is fine for the big company. They have a lot of money to spend for such activities. We just cannot afford to do that sort of thing in our little operation." Actually, the small company has a tremendous advantage over the large. They can provide the same kind of training on an individual and very personal basis. For the classroom work, they can substitute small conferences or even individual interviews with the most experienced and successful men in their company. A good man can be selected to take on the responsibility of administering a small training program in addition to his regular duties. With the solid backing of top management he can do an outstanding job of training.

In the training course which was described in detail, the classroom work was all carried on, on a full-time basis, until completed. This is a necessity in the particular company because the trainees are scattered all over the country while they are on work assignments. Several companies that have their entire operation concentrated in a single geographic area, schedule their classroom work over a longer period of time on the one-day-a-week or half-day-a-week basis. Their trainees are rotating through a series of job assignments but are all drawn out to a single meeting place at a prescribed time each week for their lecture and discussion periods. The chief advantages of this approach are: ample time is allowed between meetings to do preparatory work for the next session, and there is an adequate "soaking in" period for each subject.

Regardless of the size or type of company, a good training program can be devised to meet its needs. Every employer should feel morally obligated to provide an adequate orientation and training program for new engineering and scientific employees and to utilize such manpower at maximum potential.

SUMMARY

The first few years after graduation are a very critical period for the young engineer. He needs help in finding his best career opportunities, and he needs broad training to prepare him for the job ahead. The excellent effect of a good training program in utilizing available graduates at maximum potential is another very important consideration in these days of critical engineering and scientific manpower shortage. A short, intensive indoctrination period affords a smooth transition from academic to industrial life, and assures that each graduate is placed in a permanent position which is compatible with his major interests and best qualifications. The short delay in taking on definite job responsibilities is more than offset by the greater productivity and more rapid professional growth which inevitably results when a man is doing a job he likes to do and does well.

DISCUSSION

PRESENTED BY

H. W. PETTY, District Mgr., Uptegraff Manufacturing Co., Pittsburgh, Pa.

GUY KLEIS, Manager, Educational Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

W. J. DORWORTH, General Electric Co., Pittsburgh, Pa.

H. W. Petty: I would like to know if you are just taking in students or what you do in regard to taking in other personnel? Is your program all set up just on taking in students and coming up through the ranks, or do you hire any from the outside?

Guy Kleis: I was speaking of the program we have for the graduate engineers on the training program. That does not mean there are not opportunities for anybody else. In fact, we want to always keep the channels open so that men can work up from other jobs in the company. For instance, we have very extensive apprentice training programs and we look to such programs to provide us with a good number of our supervisory personnel in manufacturing. Some take evening work and ultimately get into engineering activities. Some of the top people in our company came up through the ranks. We are not trying to exclude anybody. An engineering degree is only a ticket of admission to the training program.

Predominantly, we try to fill the requirements of the company from the schools, bring the people in through the training program and start them off in the company. It is that group that we expect to see advance in the company to management positions. Of course, in times like these there are opportunities for others to come in. From time to time we are opening up a new plant or a new activity. We are getting into something in which we have limited previous experience. In such cases we have to look outside for engineers with experience in that field to fill the bill.

H. W. Petty: I feel the program does close the door to those who have not taken your course. Is that not right, except for new fields that you go into?

Guy Kleis: No, not entirely. During this past year, with the sudden upsurge in business, we had to hire some men to place directly in jobs. You see, there is a time lag in a training program. The average time on our course is about nine months, but the recruiting of men from the program must be started several months before college graduations. So the time lag between recruitment and placement in a permanent job has to be from 15 to 18 months. Thus, only base load requirements can be met through the training course.

The Korean affair created a need for engineers that could not possibly have been predicted in advance. As a result, our pool of men in training was far short of meeting the need. We, therefore, were forced to hire several hundred engineers, both experienced and inexperienced, to meet the emergency requirements. These men went directly into jobs without taking the training course.

Unusual or unexpected business changes make it

impossible to predict 18 months in advance just what the manpower needs are going to be. So we do hire both direct and through the student course. We prefer to have them on the course, if possible.

W. J. Dorworth: I have two questions. First, I would like to know if this company has any training programs or courses for individuals who start employment as high school graduates or non-college men, referring to such programs as business training courses or manufacturing courses?

My second question pertains to two comments that were made. One, that throughout the country there is a very small percentage or a small group of companies which are endeavoring to undertake such training programs, and also that when you solicit college graduates for your training course, (I got the impression) you were only covering your needs. We have found in our company that these other companies which do not have a training program have come to us for trained college graduates, and I would anticipate that you find the same thing. I am interested in knowing if you make allowance for that in normal times, along with the "return to the hometown" factor?

Guy Kleis: Yes, we do have a program for the non-college man. That, however, is a problem for each plant location. It is an industrial relations matter that is taken up at each location. Our biggest location is in East Pittsburgh, and there we sponsor the Westinghouse Technical Night School. We have an enrollment there of usually over 500 people who are taking courses which are somewhat equivalent to a technical institute. They can qualify at the completion of a four-year evening course for jobs in certain testing areas, for certain lab technician jobs, for certain jobs in business accounting, and so forth. We also have a very large stenographic training program there.

In addition to that, of course, we run our apprentice programs, which provide a good many people for the manufacturing organization and many of those do rise to management jobs in manufacturing.

The second question was about the percentage of companies that do have training programs. I was really amazed to find from an E.C.P.D. survey that so few companies do have really good programs. You have heard of a good number of companies that have rather fine training programs and yours, of course, numbers among those. However, there are a lot of companies that we had supposed throughout the years had training programs, that actually do very little. They bring men in and call them "engineers in training" for a couple of years, and they claim that while they are learning the job they are in training, which is true, of course. But they do very little to give them a broad background in the company, or to find the best possible job for each man.

As to the third question, regarding numbers to give away after training, your company and mine have operated differently through the years. We bring in only the number of people that we need to fill our requirements. We do not make allowance for training people for other companies as you do. We feel when we hire a man, he is coming with our company because he wants to make a career in our company, and we think that it is wise to have a job for every person we bring in. We know full well that through the years we are going to lose a certain number of people to other companies. Such people will probably serve the same general purpose that your "extra trainees" do, but in a lesser degree. However, we have found that most companies that come to us for people are looking for men with some experience beyond the training program.

There are two schools of thought on this subject, with good arguments for each side.

AID DEFENSE

MORE SCRAP TODAY . . . .

MORE STEEL TOMORROW

GET IN THE SCRAP TO KEEP STEEL COMING

NON-FERROUS SCRAP IS NEEDED TOO!

Temper Mill Symposium

. . . . the temper mill has become not only a high speed mill but a very complex and expensive unit . . . .

Temper Rolling

By J. F. SELLERS
R. M. PEEPLES
and
A. C. HALTER
Allis-Chalmers Manufacturing Co.
Milwaukee, Wisc.

▲ THE modern temper mill came into being along with the tandem cold reduction mill when cold rolling of steel strip was first started. Early coil temper mills were single stand mills with back tension obtained by means of mechanical brakes on the pay off reel, and with forward tension between the stand and a windup reel contributing toward the rolling work. Demands for increased hardness and better finishes necessitated the rerolling of many coils on these mills until, only a few years after the beginning of coil temper rolling, two stand temper mills made their appearance. This type of mill, designed for single pass coil tempering, was gradually improved mechanically as well as electrically until today these mills deliver steel at speeds up to 6000 fpm (Figure 1).

Little was published on the temper mill for many years until data appeared in articles and papers (see Bibliography) eight and ten years ago. Since then temper mills have been changed in various particulars and along with these changes there have arisen differences of opinion on the best techniques of temper rolling. These differences perhaps exist because we are not too sure of the factors in the tempering process which have the greatest influence on the final product. At any rate it appears that now is a good time to examine our experiences over the past many years in this phase of steel making and check our progress on this mill.

PRESENT POWERING OF TEMPER MILLS

As a start, a review of the existing installations of temper mills has been made to get a picture of the

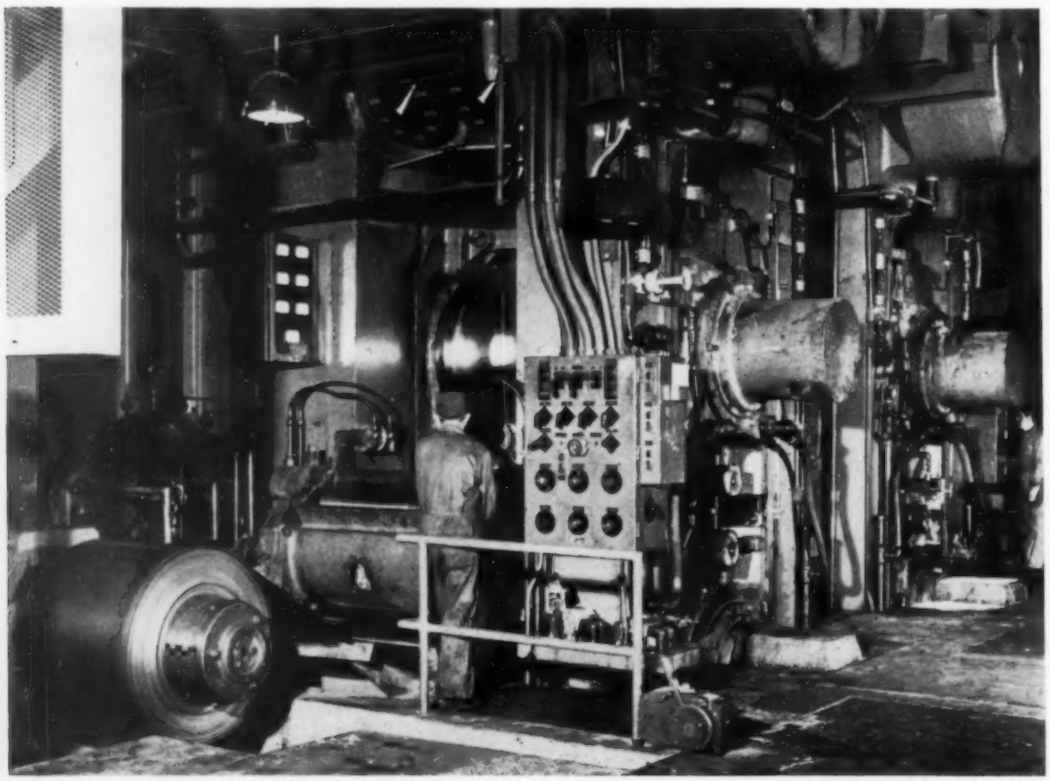


Figure 1 — Two-stand 4-high tin temper mill shown delivers steel at speeds up to 6000 fpm.

practice which has prevailed in the application of power to these mills. The motors applied to several dozen temper mills have been tabulated by listing the motor rating in horsepower on each drive—entry reel, delivery reel, tension device, and stand motors. The power applied to each drive has been reduced to a per unit basis by dividing the motor rating by the width of the mill in inches and also by the strip speed (in hundreds of fpm), the result obtained being the horsepower applied per inch of mill width per 100 fpm, a common factor of comparison applicable to all mills.

$$\frac{\text{Hp} \times 100}{\text{Fpm} \times \text{Mill Width (in.)}} = \text{hp per in. per 100 fpm} \qquad \text{(A)}$$

All temper mills reviewed were equipped with electric drives from the uncoiler to the reel, eliminating from consideration the earlier temper mill installations which uncoiled from mechanical reels or boxes. Some mills were designed to roll a wide variety of product, including gages which would be heavier than those ordinarily considered for tin plate. These mills, being more or less multi-purpose applications, were tabulated, although consideration of their ratings tended to bring up the averages of applied horsepower. On the other hand, some of the mills tabulated are now being operated over their original motor ratings, introducing the opposite effect on the calculation of averages. Mills normally devoted to sheet products were eliminated from the final consideration in this study.

The per unit power figures for the various mills are plotted chronologically in graph form, Figures 2-7 inclusive. Figure 2 shows the hp/in. width/100 fpm applied to entry reels. Figure 3 shows the application to entry tension devices. Figure 4 the application to stand No. 1. Figure 5 the application to stand No. 2. Figure 6 the application to delivery tension devices; Figure 7 the application to delivery reels. Reading from left to right the mills are plotted as nearly as possible in chronological order, according to the year of installation. Figures 3 to 6, with upper and lower lines, indicate a variable speed motor, affording a variation in motor torque. The line AV on all curves represents the average horsepower applied to the particular drive, obtained from the summation of all horsepowers divided by the number of installations considered. Where a particular installation has been made in one location with a companion mill or mills which were exact duplicates, the installation was considered as only one application for this analysis.

Maximum, minimum, and average power in hp/in. width of mill/100 fpm applied to temper mills according to the data of Figure 2 to 7 are given in Table I. The two values in the "Average" column represent averages

TABLE I

Average Installed Horsepower/Inch Mill Width/100 FPM

	Minimum	Maximum	Average
Entry reel	0.061	0.286	0.148
Entry tension	0.145	0.634	0.22 —0.385
Stand No. 1	0.255	1.625	0.419—0.802
Stand No. 2	0.267	1.625	0.500—0.914
Delivery tension	0.267	1.370	0.442—0.842
Reel	0.119	0.610	0.212

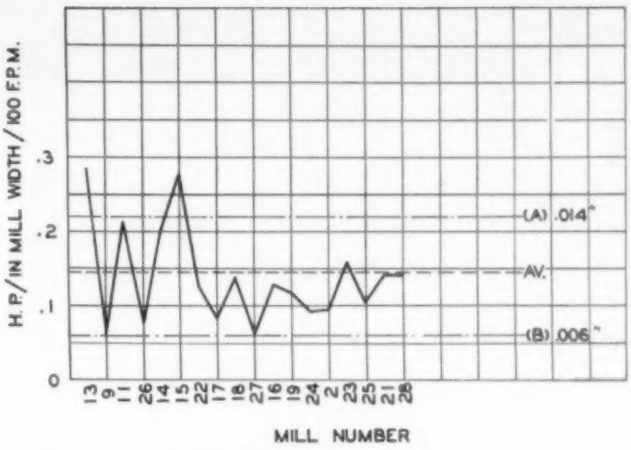


Figure 2 — Chart shows installed horsepower of entry reel for a number of mills.

of base speed and top speed per unit power for variable speed motor drives.

APPLICATION OF POWER AVERAGES

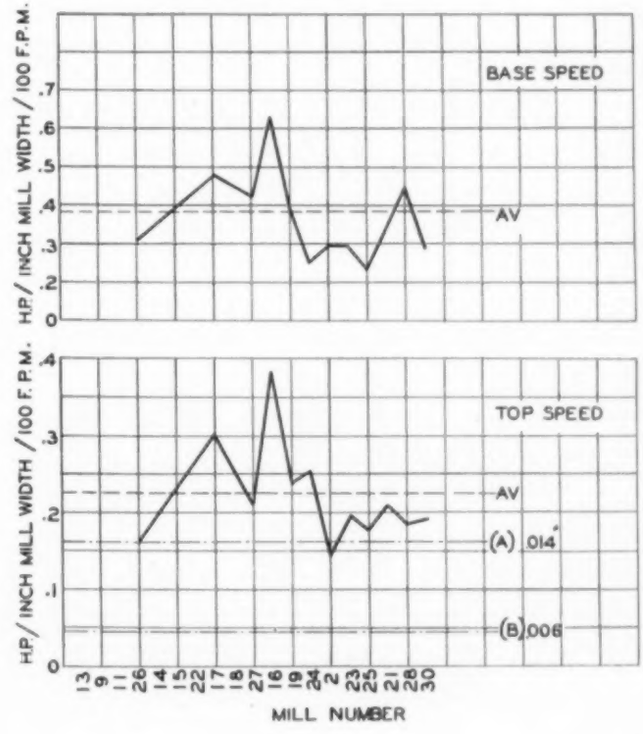
Using the data of Table I, a 42-in. mill running at 3500 fpm based on the average horsepowers applied in the past is calculated by formula (B).

Hp of the drive = Average per unit power × fpm/100 (35) × width (42) (B)

The theoretical average mill calculated in this manner would have horsepowers as shown in Table II.

The speed ranges of these motors in Table II were derived from the average values of hp/in./100 fpm for the variable speed motors shown in Table I. They,

Figure 3 — Chart shows installed horsepower of entry tension device for a number of mills.



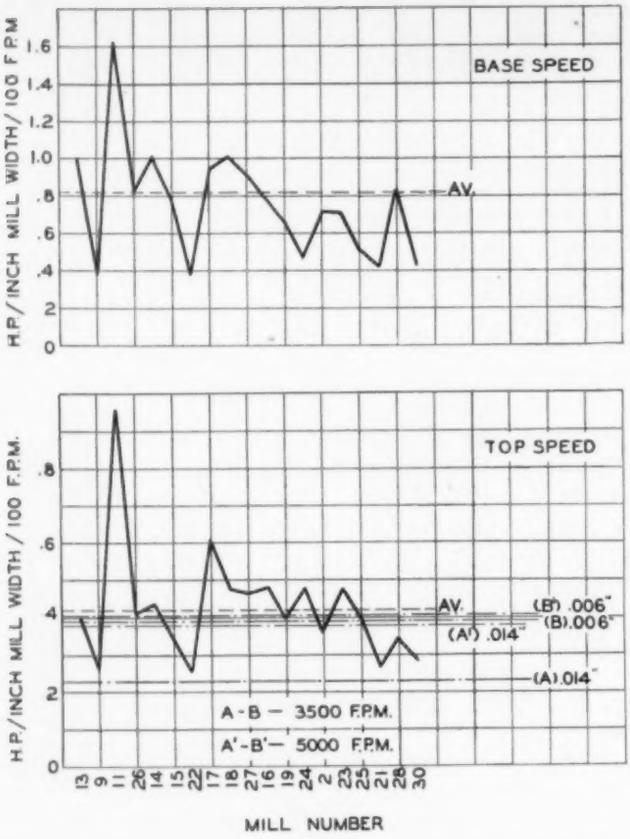


Figure 4 — Chart shows installed horsepower of stand No. 1 for a number of mills.

Figure 5 — Chart shows installed horsepower of stand No. 2 for a number of mills.

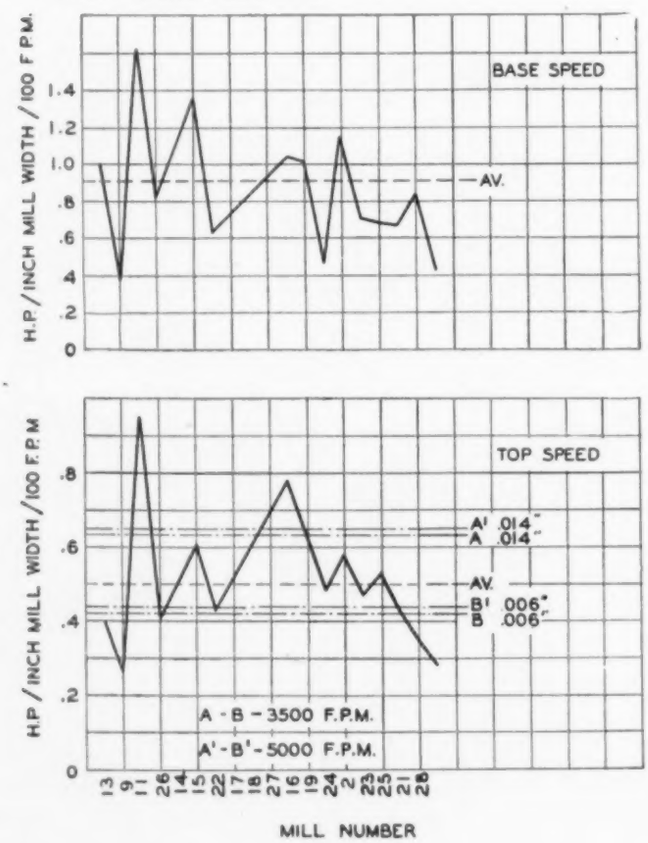


TABLE II

Theoretical Power for the "Average Installed Mill"

	HP	FPM
Entry reel	217 (162 KW)	.....
Entry tension	324 (242 KW)	3500/2000
Stand No. 1	615	3500/1830
Stand No. 2	735	3500/1915
Delivery tension	650	3500/1835
Delivery reel	312	.....

therefore, represent the average of individual drives and do not coincide in speed range. Equalizing the speeds at 3500/2000 fpm on all motors would mean that 672 hp would be required on stand No. 1, 794 hp on stand No. 2, and 708 hp on the delivery tension drive. These values, when compared with present day power ideas, check fairly well. Mills of other widths and speeds can be checked as easily with past practice, using Table I and Formula B and following the same procedure.

In using the study of past installations, however, a number of precautionary points of interest should be noted. There are wide deviations in applied horsepower occasionally apparent; there are wide speed ranges on some mills; and there is an apparent trend toward lower horsepower ratings in recent years. Probably the best reason for all these phenomena lies in the fact that there is a more definite assignment of a particular range of product to a mill today than formerly was the case.

TEMPER ROLLING POWER FORMULAS

Methods for calculation of horsepower requirements of temper rolling were first published by the Association of Iron and Steel Engineers in 1942. See Reference (1) in Bibliography. Up to now, there have been no vigorous arguments advanced to indicate that these methods should be abandoned.

Formulas (C) to (H) demonstrate the methods which were used to determine the horsepower requirements of a typical two stand temper mill.

Entry Reel (called ER in equations):

$$Hp = \frac{T_{(ER-ET)} \times \text{Area} \times \text{Fpm} \times (\text{Mechanical} \times \text{Electrical Efficiency})}{33{,}000} \qquad (C)$$

Entry Tension (called ET in equations):

$$Hp = \frac{(T_{(ET-\text{No. 1})} - T_{(ER-ET)}) \times \text{Area} \times \text{Fpm} \times (\text{Mechanical} \times \text{Electrical Efficiency})}{33{,}000} \qquad (D)$$

Stand No. 1 (called No. 1 in equations):

$$Hp = \frac{\dfrac{-(T_{(ET-\text{No. 1})} - T_{(\text{No. 1}-\text{No. 2})}) \times \text{Area} \times \text{Fpm}}{33{,}000} + \text{Rolling Power}}{\text{Mechanical Efficiency}} \qquad (E)$$

Numerals refer to Bibliography at end of article.

Stand No. 2 (called No. 2 in equations):

$$Hp = \frac{\dfrac{(T_{(No.\ 1-No.\ 2)} - T_{(No.\ 2-DT)}) \times Area \times Fpm}{33{,}000} + Rolling\ Power}{Mechanical\ Efficiency} \quad (F)$$

Delivery Tension (called DT in equations):

$$Hp = \frac{T_{(No.\ 2-DT)} - T_{(DT-DR)} \times Area \times Fpm}{33{,}000 \times (Mechanical\ Efficiency)} \quad (G)$$

Delivery Reel (called DR in equations):

$$Hp = \frac{T_{(DT-DR)} \times Area \times Fpm}{33{,}000 \times (Mechanical\ Efficiency)} \quad (H)$$

The tension (T) in these formulae represents tension in psi. These tensions were in the past selected based upon a psi in the strip sufficient to reach the elastic limit in the interval between the delivery tension device and stand No. 2, and in the interval between stands. A reasonable winding tension in psi as dictated from practice was used for the reels, such as 50 lb pull per in. of maximum strip width.

Rolling powers necessary on the stand drives came from power data established on previous mills. Calculated values of efficiency rather than test values were usually applied.

In general the tension requirements used in these formulae were somewhat empirical. Also since there were few tensiometers, power readings taken on earlier mills included all mill losses as well as the horsepower required for the difference in average rolling tensions, in front and in back of the drive. These factors were not usually separable in past calculating practice with the result that calculated horsepower values have tended to provide a margin on the high side.

TEMPER ROLLING POWER DATA

Temper mill motor application has always been handicapped by a lack of comprehensive data on mill operation which tied in with a vigorously proven theory. Due to the differences in practice between different mills, and even the differences in equipment, it has been difficult to correlate the data from separate sources. In an effort to assemble as extensive a collection of up-to-date information as possible, a survey of temper mill operations in a number of 4-high mills with 12 to 17.5-in. work rolls was recently made and added to the data already on hand.

Table III is a summary of this study, showing mill practice at various mills throughout the U. S., rolling a variety of different products. Unreasonable variations in the power values were eliminated as far as possible by taking the average of many readings.

Readings of kw and fpm were read on each drive in addition to tensiometer readings between stands No. 1 and No. 2 from which column 6 is derived. These readings were converted into tension hp and a further refinement was made by determining the actual losses existing in each mill stand, measuring the kw consumed while the mill was running idle. These figures were used instead of calculated efficiencies. Subtraction of

TABLE III

1	2	3	4	5	6	7	8	9	10	11	12
Test No.	Pounds pull ET-ER	Tension, psi ET-ER	Tension, psi ET-No. 1	No. 1 stand work hp per in. strip width per 100 fpm	Tension, psi No. 1-No. 2	No. 2 stand work hp per in. strip width per 100 fpm	Tension, psi No. 2-DT	Pounds pull DT-DR	Tension, psi DT-DR	Rockwell In-Out	Per cent extension
1 and 2	2,295	6,790	11,000	0.560	17,700	0.110	13,300	2,270	6,700	58-61	1.5
3 and 4	2,410	9,460	14,230	0.682	31,600	0.041	16,600	2,200	8,600	57-61	...
5 and 6	2,550	10,030	15,100	0.620	26,300	0.010	16,800	2,220	8,740	57-61	...
7 and 8	1,165	4,980	7,720	0.452	19,200	....	19,000	1,585	6,750	48-51	...
9 and 10	1,650	7,050	11,400	0.405	19,200	0.007	19,200	1,735	7,410	48-51.5	...
11 and 12	1,664	6,550	10,900	0.490	17,700	0.101	19,000	1,525	6,040	55-56	3.0
13 and 14	2,430	7,460	11,300	0.565	24,600	0.218	14,600	1,710	5,250	T4	...
15 and 16	2,260	8,930	13,700	0.620	31,700	0.242	18,250	1,540	6,100	T4	...
17 and 18	2,080	5,850	9,250	0.655	22,600	....	8,800	2,130	6,000	T4	...
25 and 26	1,820	6,920	16,200	0.165	30,400	....	11,400	905	3,400	55-58	...
27 and 28	2,030	6,000	17,300	0.246	23,600	0.045	16,400	2,200	6,500	54-56	...
29 and 30	1,660	8,750	26,900	0.456	31,500	0.316	12,400	1,410	7,400	53-59	...
31 and 32	2,100	6,730	9,900	0.509	14,400	0.350	16,900	1,765	6,000	57-63	1.7
33 and 34	2,160	7,870	12,100	0.416	16,400	0.350	19,500	1,790	5,860	60-65	...
35	2,760	9,050	13,300	0.576	19,800	....	9,720	1,200	3,920	57-59	1.50
36	2,800	9,160	13,650	0.587	19,300	....	13,400	2,340	7,650	57-59	1.50
37	3,140	10,300	14,650	0.174	19,800	....	13,800	2,485	8,130	54-57	...
38	2,900	9,500	14,400	0.214	21,300	....	12,500	2,180	7,130	60-60	1.0
39	2,980	5,400	9,500	0.350	14,900	....	7,500	2,500	4,540	47.5-53.5	3.0
No. 2 stand mill avg	2,250	7,730	13,300	0.450	21,200	0.092	13,100	2,750	6,000	47.5-53.5	3.0
19	6,430	3,350	.....	0.550	.....	....	14,200	10,700	5,560	44-47	0.5
20	2,280	8,500	.....	0.020	.....	....	17,400	1,300	4,830	55-59	1.0
21	3,180	4,800	.....	....	.....	....	16,500	2,420	3,640	62-62	1.0
22	3,320	9,800	.....	0.150	.....	....	17,550	2,060	6,070	51-54	1.0
23	2,670	9,900	.....	0.121	.....	....	24,600	1,960	7,500	51-55	1.0
24	7,900	21,400	.....	0.600	.....	....	40,700	6,070	16,300	59-62	2.0
No. 1 stand mill avg	4,300	9,620	.....	0.240	.....	....	24,010	4,085	7,310	.....	...

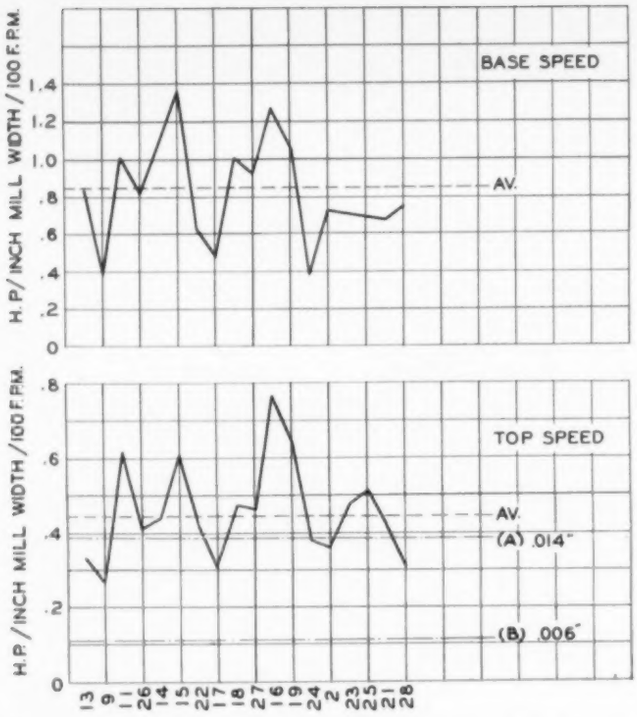
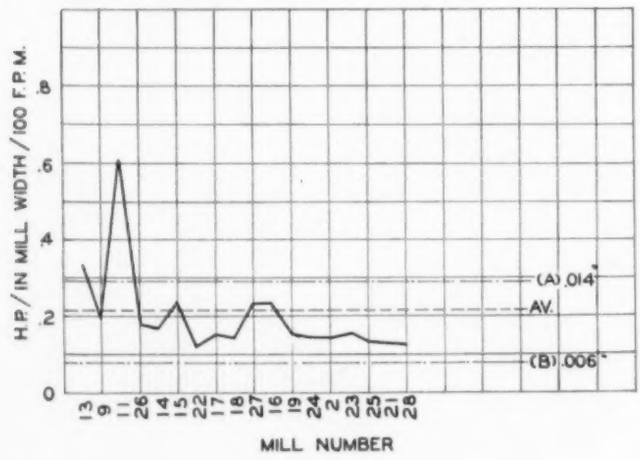


Figure 6 — Chart shows installed horsepower of delivery tension device for a number of mills.

this loss from the apparent hp at each stand produced the actual power going into strip work on the per unit basis (see columns 5 and 7) neglecting the I^2R losses.

Figure 8 shows the idle readings obtained on the drives of several different mills with the screws down at rolling pressure. These values—obtained by running the idle mill—reveal the actual mill drive and motor losses occurring before any useful work is done on the strip. Where a peculiar condition of design, installation, or maintenance exists, the friction losses on mill stands ran as high as 420 kw on a 56-in. mill, and as low as 120 kw on a 42-in. mill, both at 2600 fpm. An average of 5.7 kw at 3500 fpm per in. width appears to be a reasonable assumption for this loss. Being in great part a characteristic of the mill itself, this friction power loss becomes increasingly important at higher mill speeds. Percentage-wise it will vary with the installed horsepower.

Figure 7 — Chart shows installed horsepower of reel for a number of mills.



Information gained in the mills substantiated the assumption that the idle power losses on tension devices follow a much more consistent pattern between mills. They do not, however, always follow the constant torque characteristic as might be supposed. There will generally be an increase in kw/fpm of idle losses on these drives as their speed is increased. The maximum loss observed at high speed was in the order of 30 kw on a 400-hp drive (10 per cent of the drive rating). Reel motor idle losses are similar in character and somewhat higher with geared drives.

From the data of Table III and the mill losses as shown on Figure 8, it is now possible to calculate the average rolling power used for tin-plate products in a 4-high mill with 12 to 18-in. work rolls and to establish the relative loadings of each stand for a given speed.

The average tension values in use for a tempering operation may be obtained from columns 3, 4, 6, 8 and 10 of Table III, in psi, the value to be used being the average shown for two stand mills.

Using this value of psi for a given area, the total pull and the horsepower required at the drive to create this pull at any definite fpm may be determined according to the Formula P:

$$\text{Hp Tension} = \frac{T_{psi} \times \text{Area} \times \text{Fpm}}{33{,}000} \qquad \text{(P)}$$

From Table III—column 5, 7—may also be obtained the value of motor hp on stands No. 1 and No. 2 which go into the strip in useful work, the average value again being used. Figure 8 may be used to obtain the figure for losses sustained in the mill drive for a given rolling speed.

The calculation for motor loadings can then be carried out with the simplified Formulae I to N:

$$\text{Reel hp} = \frac{Hp_{T\ (DT-DR)}}{0.85\ (\text{Eff})} \qquad \text{(I)}$$

Delivery Tension:

$$Hp = \frac{Hp_{T\ (No.2-DT)} - Hp_{T\ (DT-DR)}}{0.9\ (\text{Eff})} \qquad \text{(J)}$$

Stand No. 2:

$$Hp = Hp_{T\ (No.1-No.2)} - Hp_{T\ (No.2-DT)} + \left(W_{M\ No.2} \times W \times \frac{\text{Fpm}}{100}\right) + Hp_{FR} \qquad \text{(K)}$$

Stand No. 1:

$$Hp = Hp_{T\ (ET-No.1)} - Hp_{T\ (No.1-No.2)} - \left(W_{M\ No.1} \times W \times \frac{\text{Fpm}}{100}\right) + Hp_{FR} \qquad \text{(L)}$$

Entry Tension:

$$Hp = \frac{Hp_{T\ (ET-No.1)} - Hp_{T\ (ER-ET)}}{0.85\ (\text{Eff})} \qquad \text{(M)}$$

Entry Reel:

$$Hp = \frac{Hp_{T\ (ER-ET)}}{0.85\ (\text{Eff})} \qquad \text{(N)}$$

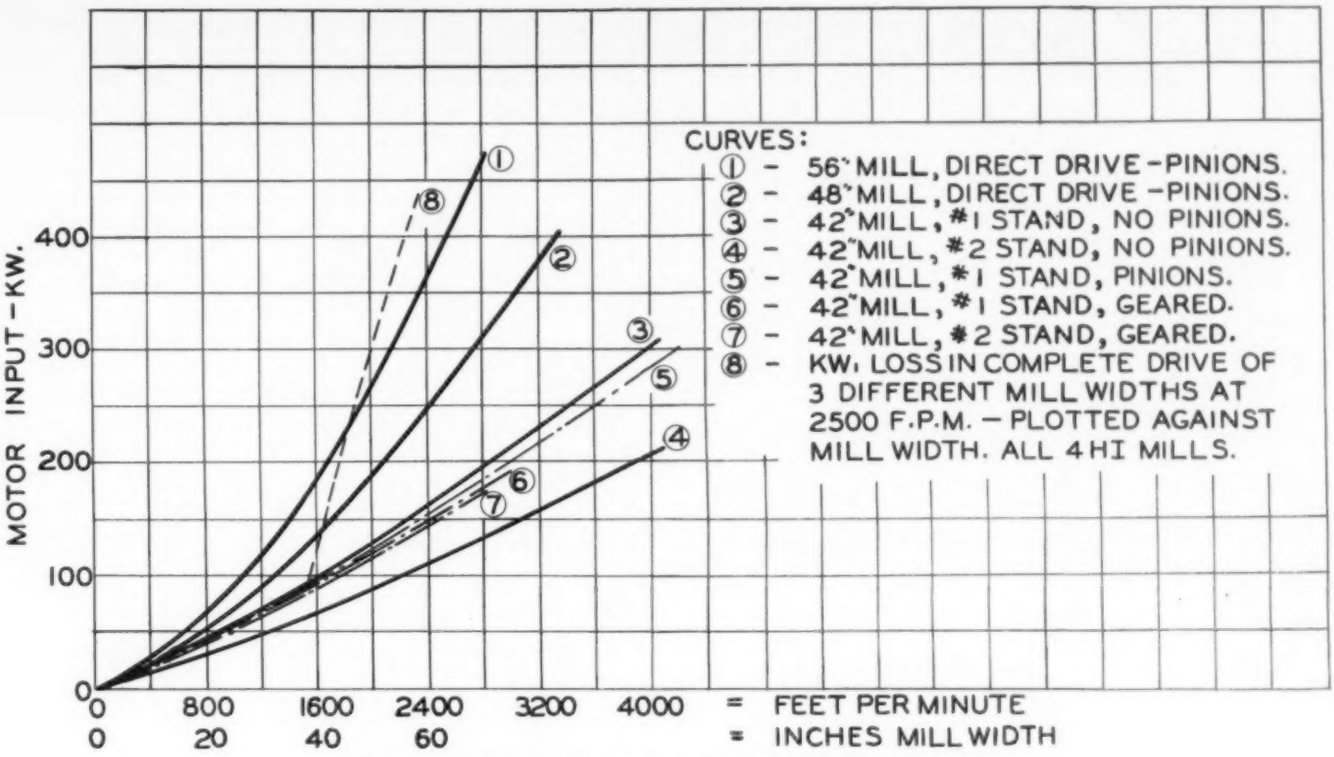

CURVES:
① - 56" MILL, DIRECT DRIVE - PINIONS.
② - 48" MILL, DIRECT DRIVE - PINIONS.
③ - 42" MILL, #1 STAND, NO PINIONS.
④ - 42" MILL, #2 STAND, NO PINIONS.
⑤ - 42" MILL, #1 STAND, PINIONS.
⑥ - 42" MILL, #1 STAND, GEARED.
⑦ - 42" MILL, #2 STAND, GEARED.
⑧ - KW. LOSS IN COMPLETE DRIVE OF 3 DIFFERENT MILL WIDTHS AT 2500 F.P.M. - PLOTTED AGAINST MILL WIDTH. ALL 4 HI MILLS.
MOTOR INPUT - KW.
0
100
200
300
400
0 800 1600 2400 3200 4000 = FEET PER MINUTE
0 20 40 60 = INCHES MILL WIDTH

Figure 8 — Curves give idle running losses for several mills and mill components.

W_M = Mill Work Factor in Hp/In. Width/100 fpm per Figure 9.

Hp_T = Tension Hp per Formula P using average T_{psi} from Table III.

Hp_{FR} = Mill, drive and Motor Loss Hp from Figure 8.

W = Width of Strip in In.

Based on the foregoing method of calculation, a compilation of the rolling power requirements of two mills, running at speeds of 3500 fpm and 5000 fpm, are shown in Table IV. In making this compilation, strip varying from 0.006 in. by 24 in. wide to 0.014 in. by 38 in. wide was considered. Horsepowers shown are those required at top speed. Compromise values for horsepower requirements are also shown below, utilizing the minimum variable speed motors capable of rolling these products.

TABLE IV

Required Mill Power Based on Average Loads

Using Single Speed Motors

	3500 fpm		5000 fpm	
	0.006 in.	0.014 in.	0.006 in.	0.014 in.
Entry reel, kw	66	245	94	350
Entry tension, kw	48	178	69	255
Stand No. 1, hp	570	337	851	797
Stand No. 2, hp	620	931	925	1370
Delivery tension, hp	157	580	224	827
Delivery reel, hp	117	430	167	615

Using Variable Speed Motors

Rolling 0.006 to 0.014 in.

	3500 fpm	5000 fpm
Entry reel, kw	245	350
Entry tension, kw	89 at 3500/1750 fpm	180 at 5000/3500 fpm
Stand No. 1, hp	570 at 3500/1750 fpm	851 at 5000/3500 fpm
Stand No. 2, hp	620 at 3500/1750 fpm	960 at 5000/3500 fpm
Delivery tension, hp	290 at 3500/1750 fpm	578 at 5000/3500 fpm
Delivery reel, hp	430	615

A comparison of these values with those in Table II provides a number of interesting differences most of which are self evident. Examining further this comparison between installed capacity and average power being used, reference may be made to Figures 2—7. Lines A, B, A^1 and B^1 of these figures are the hp/in./100 fpm for 0.014-in. strip and for 0.006-in. strip from the 42-in. mill calculated in Table IV. The position of these lines on the installed horsepower curves (Figures 2 to 7) clearly indicate how the average power used compares with average installed capacity.

HIGH TEMPER REQUIREMENTS

The greater amount of the work done on the average tin temper mill will be the production of the medium tempers. A mill designed for this requirement will probably take care of most of the mill's output. For the overall rolling program, however, some consideration must be given to the production of the higher tempers.

Many producers of tin plate today obtain the higher Rockwells out of the temper mill by control of the steel chemistry, enabling them to put into the temper mill a product of higher Rockwell hardness for the production of high Rockwell plate. It is not necessary then to impart to the steel by temper rolling any greater increase in hardness when rolling T5 grade than when rolling lower tempers. In other words a usual 2 per cent

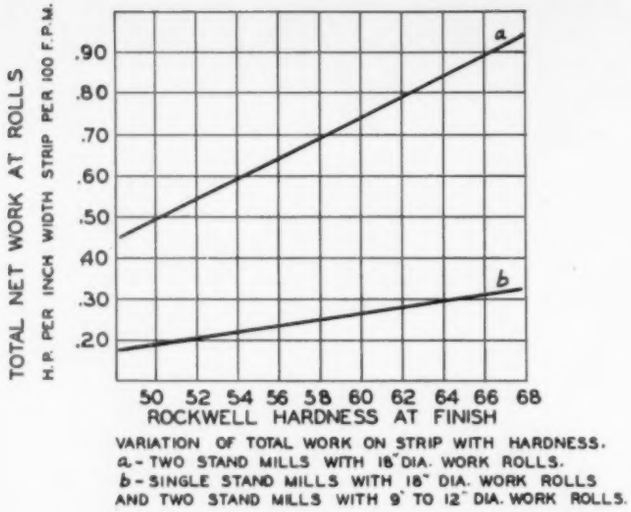

TOTAL NET WORK AT ROLLS
H.P. PER INCH WIDTH STRIP PER 100 F.P.M.
.90
.80
.70
.60
.50
.40
.30
.20
a
b
50 52 54 56 58 60 62 64 66 68
ROCKWELL HARDNESS AT FINISH
VARIATION OF TOTAL WORK ON STRIP WITH HARDNESS.
a - TWO STAND MILLS WITH 18" DIA. WORK ROLLS.
b - SINGLE STAND MILLS WITH 18" DIA. WORK ROLLS AND TWO STAND MILLS WITH 9" TO 12" DIA. WORK ROLLS.

Figure 9 — Curves show that horsepower requirements for hardness lines increase in a relatively straight line form.

extension will satisfy a T5 requirement as well as a T3 providing the incoming strip for the T5 is properly controlled.

The power necessary to produce the same extension in the T5 grade is greater than that required for the T3 grade, the work necessary to create the same surface displacement in the harder T5 material requiring the greater rolling effort. This may be due to the change in chemistry or to the hardness of the incoming steel. Tests similar to those of Table III show that this increased effort appears as an increase of the work hp developed by the stand motors.

Tension requirements do not necessarily increase, although, when rolling the higher temper materials, higher tensions are usually used to help in the reducing process and to shift the loads from the stand motors. That portion of the rolling hp used in a two-stand mill which is devoted to strip work has been plotted against strip hardness in Figure 9, work hp being expressed in hp per inch strip width per 100 fpm, and hardness in Rockwell units. To obtain the curve, work hp values for both stands were secured by collecting information on many materials and figuring the work devoted to the strip according to the previous formula. The work hp figures for stands No. 1 and No. 2 were then added from columns 5 and 7 of Table III for use in this curve. Extension gained by the horsepowers of Figure 9 was between 1 and 2 per cent for all degrees of hardness. From this data it is logical to assume that the horsepower requirements for the hardness ranges T3 to T6 increase in a relatively straight line form as shown in Figure 9. For different values of reduction the curve is moved upward or downward.

It is, therefore, apparent that calculations made for mill work based on average tempers must be increased for the same work on T6. Using this data of Figure 9, we note that 0.6 hp per inch per 100 fpm will be utilized for T3 temper while for a temper in the T6 range the unit hp requirement increased to 0.9. It is important in this connection to bear in mind that the work hp is only a portion of the total hp being produced by the mill drive so that the total horsepower applied will not be increased by the 0.9 to 0.6 ratio. A mill figured for the average material will require an addition to the mill total horsepower for high temper work in either overload capacity or in increased power. The 42-in. mill of Table IV running at 3500 fpm and 5000 fpm will need an increase in horsepower based on the difference between the average and the high temper requirement. For the T6 and T3 materials, this difference is 0.9 — 0.6 or 0.3 hp per in. width per 100 fpm. At 3500 fpm the maximum requirement, a 38-in. strip, would require on this basis $38 \times 0.3 \times 3500/100$ or 400 hp added to the mill.

At 5000 fpm, the logical maximum width strip (assume 28 in.) would require 360 hp additional.

It is furthermore not necessary to add all this additional power to the stand motors. It may be distributed among the motors of stand No. 1, stand No. 2 and the delivery tension device. For the mill of Table IV, we believe the T6 requirement is adequately served by adding 200 hp to the delivery tension device and 100 hp to each stand motor. The stand motors as proposed in Table IV will have this additional power in normal overload capacity, but the tension device motor will require an increase in rating of at least 150 hp to roll T6 within temperature rise limits.

MILL WK^2 REQUIREMENTS AND FINAL MOTOR SELECTION

Several other factors bear upon the selection of power for a temper mill, not the least of these being the WK^2 requirement of the mill and drive. While it is not as important in temper rolling to get up to speed as fast as in cold rolling, it nevertheless becomes increasingly important as the top speed increases to be able to handle the mill from top speed to thread in as short a time as is reasonably possible. It is thus necessary to reexamine the mill horsepowers, with accelerating and decelerating time stipulated in advance. Should standard overload capacity of the motor required for rolling be insufficient to handle accelerations in the desired time, an increase of the motor size becomes necessary. Economically speaking, there is a ceiling limit to top speeds beyond which mill performance in terms of acceleration time must be paid for directly in terms of excess hp or overload capacity.

According to Table IV, the average motor horsepower for a 42-in. mill at 3500 fpm is approximately 600 for No. 1 and No. 2 stands. This amounts to 600/35 or 17.15 hp per 100 fpm. Assuming this to be a standard motor, the capacity, for repeated loads, is 175 per cent of its rating. Therefore, acceleration for the mill stands may be permitted to absorb 0.75×17.15 hp or 12.9 hp per 100 fpm.

A typical mill stand for an 18-in. and 49-in. × 42-in. temper mill with a total WK^2 of approximately 20,000 lb ft^2 can then be accelerated utilizing a total of 12.9 hp per 100 fpm, but at a rate dependent in part on the type of motor construction employed. For instance, a single armature of 17.15 hp per 100 fpm will have a WK^2 of 1900 lb ft^2. Using the formula:

$$\text{Maximum hp of acceleration} = \frac{WK^2 \times (\text{Rpm})^2}{\text{Time in sec} \times 1.615 \times 10^6}$$

TABLE V

Minimum Accelerating Periods of Mill Stands with Motors of Standard Overload Capacity

Type of mill		18 in. and 49 in. x 42 in. with 18-in. roll driven by 600 hp	9 in. and 38 in. x 48 in. with 38-in. roll driven by 600 hp	27 in. x 48 in. two high driven by 600 hp	21 in. and 53 in. x 56 in. with 21-in. roll driven by 800 hp
Minimum time in sec to accelerate per 100 fpm —	S.A.-S.S.	0.470	0.291	0.178	0.525
	S.A.-M.S.	0.510	0.346	0.221	0.560
	D.A.-M.S.	0.484	0.313	0.197	0.556
	4 A.-M.S.	0.462	0.294	0.196	0.533
Per cent of total accelerating amp used to accelerate mill parts only —	S.A.-S.S.	91.5	92.5	88.2	91.0
	S.A.-M.S.	84.0	77.8	70.5	85.1
	D.A.-M.S.	88.8	86.0	79.1	85.3
	4 A.-M.S.	93.0	91.5	80.5	85.8

S.A.-S.S. = Single Armature Single Speed Mill Motor
S.A.-M.S. = Single Armature Multi-Speed Mill Motor
D.A.-M.S. = Double Armature Multi-Speed Mill Motor
4 A.-M.S. = Four Armature Multi-Speed Mill Motor

It can be shown that this motor will accelerate itself and the mill at a rate of 0.470 seconds per 100 fpm. If a single armature motor is chosen with a 2.5 to 1 speed range, it will then add to the mill WK^2, 3800 lb ft^2, or twice as much as the single speed construction. Acceleration of this motor and drive will be at a slower rate, 0.51 seconds per 100 fpm. A choice of a double armature motor with a 2.5 to 1 speed range results in a value of motor WK^2 of 2560 lb ft^2, which is between the two previous choices. Acceleration with this motor can be handled at 0.484 sec per 100 fpm.

Table V presents data pertinent to these accelerating problems on the temper mill. Part of the table shows per unit time of acceleration for several kinds of mills driven by motors of different construction, from single armature to a 4-armature, dual drive. The assumption is made that horsepowers of 600 and 800 are to be used and the standard 75 per cent overload utilized for acceleration. From this data, it is apparent that the type of motor construction to be employed will not have a great deal to do with determining the total WK^2 horsepower required. The mill parts themselves represent the larger part of the WK^2. The lower section of Table V illustrates this fact by listing the percentage of total WK^2 power taken up by the mill parts for the motor and mill combinations used in the table.

Referring to the time data of the table, it can be seen that accelerations up to 5000 fpm will be obtained in 8.9 seconds to 11 seconds on the easiest mill to accelerate, and from 26 seconds to 28 seconds on the worst, the variation being due to the type of motor employed. It would therefore seem logical to employ a motor construction best suited to the installation and space requirements on the drive, and for faster accelerating times, concentrate on obtaining more motor overload capacity.

Considering mill drives as a whole, the horsepowers required for acceleration by one or another of the mill stands is usually the limiting factor in determining acceleration time. The smaller drives, such as tension devices and reels seldom require near as much power to accelerate except where very large coils are to be used. Then the power required to overcome the WK^2 of the coil itself is a very large factor and should always be considered.

Final choice of motors for a temper mill also involves several other factors aside from the WK^2 requirement. These concern the choice of roll to be driven, and its diameter, the necessary decision regarding the driving of stands and tension devices on one roll or two rolls, the mounting and space problem, and the overall economics of the installation. Most of these factors, including the WK^2 problem, are interdependent to a large degree.

The mill schedule, one of the most important factors in the economic analysis, introduces a final consideration. Referring to Table IV, it can be seen that for both speeds at which the typical drive is projected there are two thicknesses of strip listed. Assuming that the same treatment will be accorded both thicknesses, the horsepowers required to temper pass the increased thickness will be greater than that necessary to treat the thin strip in proportion to the areas. Theoretically, therefore, the mill power should be chosen on an RMS basis for the greatest area to be rolled.

According to Table IV, gages of 0.006 in. could be rolled at 5000 fpm with a motor 925 hp and gages of 0.014 in. with a motor of 1370 hp. However, the same operations can be done with a 925-hp motor providing the base speed is lowered to 3380 fpm, or with a 960-hp motor at a base speed of 3500 fpm. There is, therefore, a saving in original cost with the lower base speed motor rolling the heavier materials at a slower speed. This is particularly true with respect to the generators and control backing up the motors. With respect to the motors themselves, lowering the base speed has little effect on motor cost, since the torque is not changed.

The decision on this point is fundamental. Should the mill be one which is expected to handle a wide variety of gages, there is a good deal to be said for the wide variation in motor speed by field weakening. On the other hand, if it is possible to concentrate on a particular product with the contemplated mill and shunt border line production to other units, probably a greater gain can be obtained by concentrating on maximum speed.

SEPARATE GENERATOR VS COMMON BUS DRIVES

Outside of mill powering itself, probably the most interesting problem discussed today concerns the question of supplying the mill motors from a common bus or from a separate generator for each motor.

These are several individual generator drives in operation on temper mills at the present time which are working out very well. Technical problems are as well solved with this line-up as they are with the common bus. However, the individual generator scheme as applied to a new temper mill does not present as many advantages as it might in a cold reduction mill, except that it is easier to apply machines of different voltages on one mill. This could be an advantage in a revamping job, as well as for reel or drag generator drives.

By and large, this question is too extensive to allow examination of the details in this paper. The choice between the separate generator and common bus drives is undoubtedly based on economics more than any other factor. As a general rule, with drives in the lower horsepower ratings, the separate generator scheme will be found to be higher in original cost. Figures 10 and 11 show schematically these two mill drive arrangements.

VARIABLE TORQUE OPERATION

For variable torque operation two systems are in use:

1. Use of full torque on all motor fields with acceleration to base speed by generator voltage, and beyond base speed by weakening of all motor fields.
2. Presetting of all motor fields by a motor operated rheostat, or presetting at definite speed points by transfer switching.

Use of full torque at low speeds presents the advantage of having maximum available torque at hand during startup, and the advantage of having a constant rate of acceleration to all speeds. For a wide variation in motor torque, however, use of this system means that two fluxes must be changed to get up to speed (that of the generator and that of the motors). Where a two-to-one torque range is used, the flux of the generator must be changed in half the time that is required for the same speed change using pre-set fields. Careful use of machines and control are necessary for the success of this system.

The preset field necessitates use of a variable speed accelerating rheostat for different top speeds or a system of changing the WK^2 compensation with a change of top speed setting. Use of the motor operated rheostat field setting device requires training of the operators and a little extra margin of protection of the regulating means for the operational errors.

Many years of experience with temper mills using varying torque during accelerating has led to the conclusion that for fast accelerations the preset field idea is inherently a smoother method of operation.

MILL TENSION REGULATION

The methods of temper mill regulation are now pretty well established, the aim, or course, being to keep tension constant at every interval between drives in the mill.

Between the mill stands it is obvious that it is practically a necessity to use the tensiometer as a measure of "feeling" the tension and correcting the mill motor inputs to maintain the tension value constant. Figure 8 illustrates why this is necessary. Friction losses in the mills themselves sometimes get to be a relatively large percentage of the input power. This loss does not follow a straight line ratio with speed. It is not the same with rolls of different surfaces, nor is it certain that different mill bearings will produce the same losses. On some mills the loss in the mill itself increases radically with speed, so that at high speed the power appearing in the strip is a smaller percentage of the motor rated output, than it is at thread. On another mill, the deviation may be more moderate. Additional complications are added by the I^2R losses at low speeds.

Those mills which are operating successfully today with tensiometers, undoubtedly do so because their mill losses approach a constant torque characteristic. The operators have learned to use their mills so that conditions are more or less balanced. The motors driving the mills have good regulation and the speed relationship is not too much disturbed. Proper adjustment of these factors makes a satisfactory mill. However, in the higher speed mills where the mill losses become more critical, the operation of a mill without the tensiometer should be considered only as a back-up measure for emergency use.

On the tension roll devices the situation is slightly different. Since the total losses (except I^2R) in these drives runs in the order of 10 per cent, a regulator controlling the current input into this drive will be 90 per cent accurate as a tension regulator under the worst conditions. Since the losses are also a relatively stable figure, it is possible to compensate the current regulator for these losses, enabling it to automatically increase motor input with the drop in efficiency, if necessary, thus increasing the accuracy of tension regulation. Tensiometers for this reason appear unjustified in tension roll regulation.

METHODS OF REGULATION

Regulation has been applied on temper mills in three different manners:

1. By use of the motor field to regulate current or tension.
2. By use of separate generators regulating current or tension.
3. By use of boosters to regulate current or tension.

The regulating means must compensate for the variables in the mill setup including an extension variation, the temperature variation, and the variation in sizes of rolls being used. In all cases there must be a bit to spare in the regulating means for forcing requirements.

1. Where motor field regulation is used, the motor field range must contain the margin necessary for extension, roll changes, temperature variation and motor droop. In order to cancel the effect of I^2R losses, boosters are necessary. If these cannot be set at 100 per cent compensation when current regulation is used, the tension regulation is inaccurate in proportion to the deviation from this

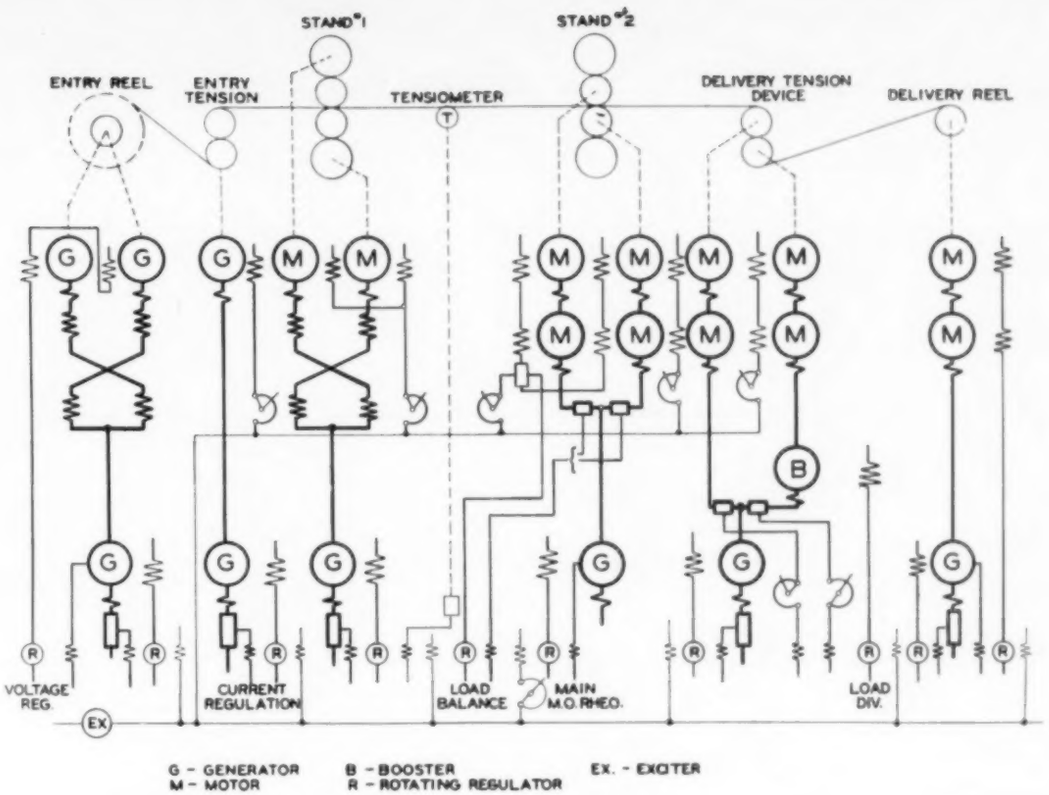


Figure 10—Typical schematic of 2-stand temper mill with separate generators on each drive.

value. To improve the situation, a tensiometer is required even though the booster cannot be dispensed with on a high speed mill. The regulating duty adds to the field range necessary in the motor, making for an overall regulating system with severe limitations on high speed mills.

2. Current or tension regulation by variation of the applied armature voltage is better and more easily accomplished. Both the separate supporting generator or a booster in series with the motor lend themselves to this type of regulation.

   The I^2R losses are automatically compensated when current regulation of this type is used. When used in conjunction with a tensiometer, all losses are taken care of. Current regulation used with a separate generator automatically takes care of extension and resistance variation due to temperature changes, and will also handle without trouble the variations in set up due to roll diameter differences. These variations are taken up by the supporting machines rather than by the motor field. The only precaution necessary is a routine protection against over-voltage under extreme conditions.

3. With a booster in series with the motor on a common bus lineup, the same things can be done as with the separate generator but a little more care is required in choosing the booster ratings. The variations of extension, temperature and regulating requirements must be taken care of in addition to compensation for speed changes due to roll diameter. By using the booster in both the positive and negative directions, its rating can be kept as low as possible. At the same time it is more economical to choose a voltage rating close to a standard voltage. The optimum choice of booster rating is a compromise between high voltage and low power. It is possible to vary the motor field according to the variations in the rolls, thus reducing the amount of change necessary in the motor terminal EMF and at the same time reducing the booster rating. This appears to be the only practical reason for varying the motor field flux with this scheme.

With any of the foregoing motor regulating methods, use of a voltage regulator to stabilize the mill is mandatory for low voltage thread speeds. In case separate generators are used, the regulator used for mill motor control is converted to a voltage regulator to stabilize and synchronize the drives at low speed.

REEL AND UNWINDER REGULATION

Little need be said regarding reels that has not been said before. Any number of adequate reel controls are in use today, the patents on features of reel drives being numerous.

Current regulation is still apparently satisfactory. However, as mill speeds go up, several factors become more important if we rigorously adhere to the concept of constant tension:

1. Current regulators using motor fields, and coil build up regulation not compensated fully for IR drop will reflect heavy tension errors at thread speeds.
2. Reel losses, like the losses in tension devices, apparently do not follow the constant torque curve, hence, at high speeds there may be some error in controlling tension by current regulation. From present experience, we can assume this error is within permissible tolerances, keeping in mind that this error reflects itself in the tension between the tension device and the mill stand.
3. The recognized principle of applying a variable

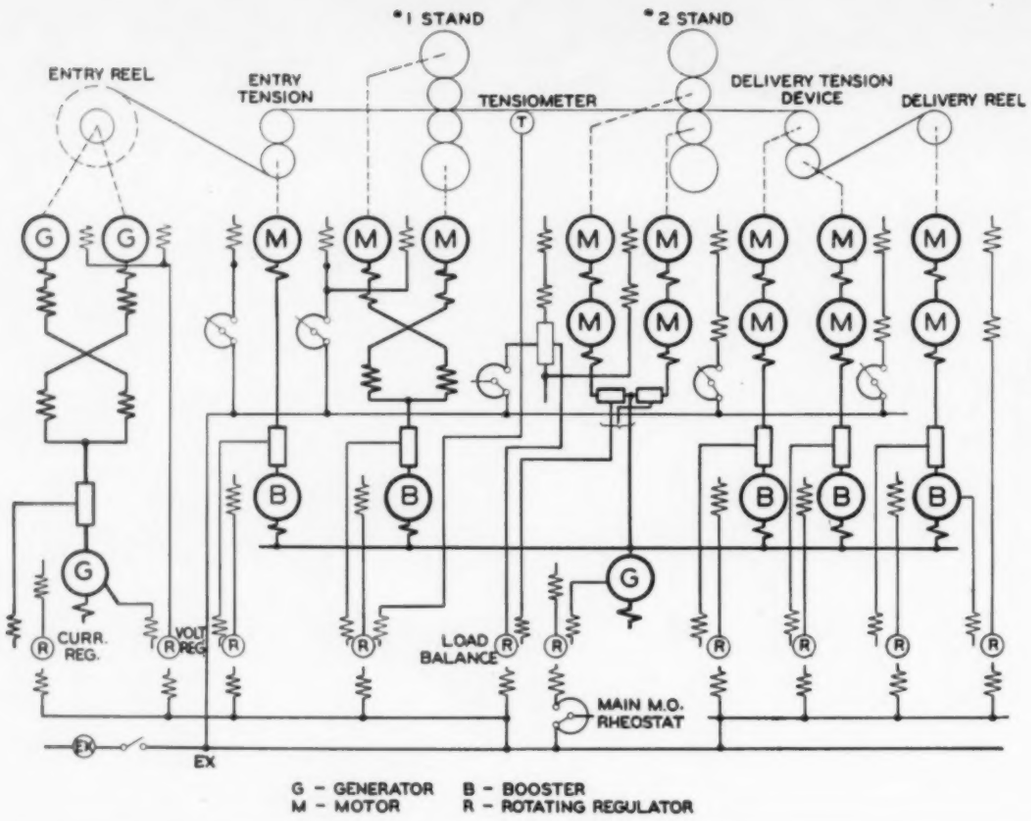


Figure 11 — Typical schematic of 2-stand temper mill with common generator on mill and reel.

WK^2 to reels and unwinding devices according to the size of the coil on the mandrel becomes critical with high speed acceleration and the huge coils used today. It is no longer good practice to overcompensate. The variation is too large to be neglected in most cases.

LOAD BALANCING ON MILL AND TENSION ROLL DEVICES

There are two places on the temper mill where a balancing of motor loads must be considered. These occur when motors are applied on top and bottom rolls of the stand drives and the tension devices. It is a little beyond the scope of this paper to discuss the reasons for dual drives. Where dual drives are to be used, the question then concerning the electrical designer is the degree of load balance necessary.

On mill stands, the loads on the two rolls should theoretically be approximately equal. Deviations in the roll sizes and deviations in the settings due to temperature or design tolerances normally would be the factors contributing to unbalanced loads.

Motors can be built with specific regulation characteristics which in combination with line resistors or regulating fields, will take care of a 10 per cent difference in motor rpm, balancing the loads within 10 per cent. There is no real reason why this should not be good enough for a temper mill.

Where it is specifically required that rolls are to be used which will run, the difference in rpm on each motor over a wider range, or where the load balance must be closer, additional equipment must be added in the form of load balance regulators. Their application is now quite common.

On tension roll devices where separate motors drive each roll, the same theories may be advanced except that it is necessary to state that the theoretically most desirable condition is not one of balanced load between top and bottom drive. This point can be illustrated in the following.

According to the accepted rule, the tension roll drives cannot transmit tension to the strip through their frictional contact in an amount greater than three times that being delivered from the reel, this rule being based on the fact that the power to be transmitted to the strip through the tensioning rolls depends upon the coefficient of friction between the roll and strip and the amount of pressure holding the strip against the roll. The pressure of strip against roll is in turn a function of the tension in the strip. If the power to be delivered is great enough, it therefore is necessary to apply tension motors at two places (on both rolls). The tension in the strip leaving the bottom roll is that being delivered by the reel, while the tension in the strip leaving the top roll is greater than that leaving at the bottom by the amount added by the lower tension motor.

By this reasoning, the top motor on the tension device should be larger than the bottom. Or, if the advantages of duplication dictate that the two motors should be alike, the optimum performance would occur with the top motor delivering more power. Slipping should occur first on the bottom roll at equal loads and would consequently limit the output of the top drive.

These motors may be used in parallel on a single generator using a single booster with the resistance of the armature circuit, motor regulation, and field settings adjusted to achieve the desired division of current similar to the roll drive application. This would be a fixed setting adjustable only within a narrow range, but would be perfectly workable. A more popular method

of handling the two motors is to treat them as individual drives with their own supporting regulating equipment. From the standpoint of electrical performance the latter method is recommended.

CONTROL FEATURES

The most obvious change in temper rolling since its inception is the general acceptance of belt wrapping and threading on the fly. Where it was thought impossible to thread a temper mill without prohibitive roll marking in the early days, it is now a general practice to try to cut down the threading delays by "on the fly" arrangements. Mill stand controls are arranged with this in mind. The thread or idle speeds of the mill are set up so that the motor characteristics make it as easy to stick as possible. With separate generators this means that the tension regulators hold a thread voltage for idle running which results in a "soft" mill. Adjustments to change the thread conditions are provided on the operators' cabinets. Boosters in the motor drives are handled likewise.

To aid this operation, jog switches handling a multiple number of motors are provided; Stand No. 1 jogs with the entry machines and stand No. 2 with the delivery machines. Individual jog switches are standard features on each stand.

Controls to apply and remove the entry tensions at will are provided at the entry stations with the other tensions arranged to be applied automatically. Optional provision allows the tensiometer to be introduced manually if desired.

Two-man mills are the rule with full operating controls at delivery and entry stations. The entire mill metering is usually placed at the delivery operator's station and the pertinent entry metering at the entry station. Controls in between stands are usually only those necessary for the control of stand No. 1 and No. 2 and include tensiometer controls. Metering is at a minimum at the between stands station. Tension controls from stand No. 1 to the delivery end are usually given the delivery operator. Entry tension controls remain at the entry station.

The chief relaying assignment in this type of mill outside of the threading circuits involves the necessity of getting tension regulators, in the form of current regulators or tensiometers, into operation when the mill is started, and removing them when the mill is stopped. With the multiplicity of machines being used and the increase in ratings being applied, controls for a temper mill have grown to be one of the larger jobs in the industry.

SUMMARY

It is apparent from the foregoing discussion that a great many angles have been introduced into the temper mill application problem over the past many years. As has been shown, however, it is possible today to go over past experience and observe the progress on this unit. The temper mill is now a high speed mill, it is more complex, and it is more expensive. It might be indeed classified as one of the most complex of the modern steel mill machines. This discussion has attempted to outline, without going into too much detail, the main lines of thought which are followed today in applying temper mill drives. We believe, as pointed out in the article, that we are not only extending our thinking of yesterday but crystallizing both the engineering approach to the problem and the position of the temper mill in the steel working process.

BIBLIOGRAPHY

1. "*The Temper Mill*," by T. B. Montgomery, AISE Proceedings, 1942.

2. "*The Uni-Temper Mill and Process*," by M. D. Stone, AISE Proceedings, 1945.

Power Requirements

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▲ Temper or skin rolling is the cold rolling of coils, sheets or strips with only sufficient reduction to flatten, to improve the surface and to stiffen or temper them. The reduction in temper rolling is usually five per cent or less but may run as high as 10 per cent, or even more in some cases, depending on the characteristics of the incoming metal and of the finished product.

TEMPER MILLS

Most temper rolling is done on single-stand mills with tension reels where material is handled in strip form and with suitable feeders and pilers where material is handled in sheet form. While the temper rolling of sheets will continue, for obvious reasons, to be done on single-stand mills, there is a developing trend toward the use

Figure 1 — Two-stand temper mill shown was installed in 1949. Winding reel is on left, feed reel is on right.

of two-stand tandem, or "twin" temper mills for the temper rolling of strip steel, particularly for tinplate gages. Several such mills have been placed in operation in recent years and several have been in use for five years and more. The two-stand mill is capable of greater reductions and can also produce a greater strip tension between stands than can be obtained between a single stand mill and its reel, even when pullers or tension devices are used. This greater tension tends to improve flatness and to produce a better product than can be obtained by rolling alone. Figure 1 shows a typical, modern two-stand temper mill.

Rolling speeds are also increasing. Several two-stand mills with delivery speeds in excess of 4500 fpm have been or are being built. At least one mill is operating consistently at 5000 fpm. It is to be expected that single stand mills built in the future will have comparable speeds.

As rolling speeds increase and mills become more complex, the selection of electric drives becomes more difficult and a greater knowledge of power requirements more necessary. It is the hope of the authors that the information contained in this paper will contribute to this knowledge and encourage others to develop and extend this study.

REEL POWER REQUIREMENTS

The steady state power requirements of reels can be calculated with good accuracy since the entire load consists of tension and mechanical losses. The rating of reel motors, however, must not be selected without considering the transient accelerating and decelerating loads. As will be shown, these are particularly important when considering direct connected or 1:1 geared drives where large coils are to be handled.

The horsepower or kilowatts required to produce a given tension are given by the familiar relations:

$$Hp = \frac{\text{Tension} \times \text{Fpm}}{33{,}000 \times \text{Efficiency}} \text{ for winding reels}$$

or

$$Kw = \frac{\text{Tension} \times \text{Fpm}}{33{,}000 \times 0.746} \times \text{Efficiency for feed reels}$$

Using these equations, the normal running load may be determined. The efficiency used is the mechanical efficiency of the drive and will be 90-95 per cent for geared drives and 95-98 per cent for direct drives. The value of tension to be maintained will naturally vary with the cross section of the material to be handled and with the quality of the coils. Winding reels are usually operated at higher values of tension than feed reels in order to obtain tight coils which are easily handled without damage. In addition the coils on the feed reel are often more or less deformed in the annealing process and are apt to have damaged edges and "stickers" which will cause strip breaks if high tension is maintained. Feed reel tension will vary from 3000 to 6000 psi and winding reel tensions from 6000 to 9000 psi depending on mill practice and requirements.

Accelerating and decelerating loads should be calculated and added to the tension loads to obtain the maximum peak loads which will be imposed upon the electrical machines. To calculate these loads, the inertia or Wk^2 of the motors, the reels and the coils must be obtained or calculated, and an accelerating rate must be established. While mill speeds are increasing yearly, there is a tendency to specify even shorter accelerating times than have been common in the past. This is only natural because it results in better utilization of the mill and in greater production, but the resulting accelerating rates, being directly proportional to mill speed and inversely proportional to accelerating time, may give rise to excessive peak loads on the electrical equipment. For instance, accelerating times of 15 to 20 seconds and mill speeds of 2500 to 3500 fpm have been widely used. The accelerating rates of such mills vary from 125 to 250 fpm per second. Today it is not at all uncommon to talk of 10 second accelerating time for mills rated 4000 to 6000 fpm, requiring accelerating rates of 400 to 600 fpm per second, or roughly twice as large as those previously considered. Such high rates are often not practical as will be shown.

As an example, consider a tension reel with a Wk^2 of 1500 lb-ft^2, direct connected to a 300/1500 rpm motor with a Wk^2 of 3200 lb-ft^2, designed to handle 16-in. ID × 72-in. OD coils of 0.0088-in. strip, 42 in. wide. The coil Wk^2 may be determined from Table I as 42(5172—12.61) = 222,000 lb-ft^2. Thus the total con-

TABLE I

Wk^2 of Solid Steel Cylinders 1 In. Long

Diam in in.	Wk^2	Diam in in.	Wk^2
11	2.818	46	861.8
12	3.991	47	939.3
13	5.497	48	1021.8
14	7.395	49	1109.6
15	9.745	50	1203.1
16	12.61	51	1302.2
17	16.07	52	1407.4
18	20.21	53	1518.8
19	25.08	54	1636.7
20	30.79	55	1761.4
21	37.43	56	1893.1
22	45.09	57	2031.9
23	53.87	58	2178.3
24	63.86	59	2332.5
25	75.19	60	2494.7
26	87.96	61	2665.2
27	102.30	62	2844.3
28	118.31	63	3032.3
29	136.14	64	3229.5
30	155.92	65	3436.1
31	177.77	66	3652.5
32	201.8	67	3879.0
33	228.2	68	4115.7
34	257.2	69	4363.2
35	288.8	70	4621.7
36	323.2	71	4891.5
37	360.7	72	5172
38	401.3	73	5466
39	445.3	74	5772
40	492.78	75	6090
41	543.9	76	6422
42	598.8	77	6767
43	658.1	78	7125
44	721.4	79	7498
45	789.3	80	7885

Wk^2 given in lb-ft^2.
Based on steel at 487 lb per cubic foot.

nected Wk^2 is 222,000+3200+1500=226,700 lb-ft². The torque required to accelerate this inertia in ten seconds is calculated:

$$T=\frac{Wk^2\ N}{308\ t}=\frac{226{,}700\times 300}{308\times 10}=22{,}100\ \text{lb-ft}$$

and the torque required to produce an average value of 7500 psi tension may be obtained as follows:
Tension = $7500\times 42\times 0.0088=2770$ lb

$$Fpm=\frac{72\times\pi}{12}\times 300=5650\ \text{fpm}$$

$$Hp=\frac{2770\times 5650}{33{,}000\times 0.98}=484\ \text{hp}$$

$$T=\frac{Hp}{Rpm}\times 5252=\frac{484}{300}\times 5252=8320$$

Thus it may be seen that in the selected case, the accelerating load is 2.65 times the load required to produce an average value of running tension, and if motors of normal overload capacity are to be used, the motor size must be based upon the accelerating peak. Most modern mill motors are rated for 175 per cent frequently repeated peak loads at base speed which leads to the following selection:

$$Hp=\frac{(\text{Tension torque}+\text{accelerating torque})\times \text{rpm}}{5252\times 1.75}$$

$$=\frac{(22100+8320)\times 300}{5252\times 1.75}=1000\ \text{hp}$$

$$\text{Full load torque at 300 rpm}=\frac{1000}{300}\times 5252=17{,}500\ \text{lb-ft}$$

$$\text{Per cent load to produce tension}=\frac{8{,}320}{17{,}500}=48$$

$$\text{Per cent load to accelerate}=\frac{22{,}100}{17{,}500}=127$$

The selected motor, while no larger than necessary from the standpoint of accelerating peaks, is actually capable of producing more than twice the required tension.

Another important, and often neglected, factor is the change in accelerating load with coil buildup. The accelerating load with an empty reel for the above drive may be calculated in a similar manner:

$$\text{Rpm with 16-in. empty reel}=\frac{5650\ \text{fpm}}{16/12\times\pi}=1350\ \text{rpm}$$

Empty reel $Wk^2=1500+3200=4700$ lb-ft²

$$T=\frac{4700\times 1350}{308\times 10}=2060\ \text{lb-ft}$$

Full load motor torque at

$$1350\ \text{rpm}=\frac{1000}{1350}\times 5252=3900\ \text{lb-ft}$$

$$\text{Per cent load to accelerate empty reel}=\frac{2060}{3900}=53$$

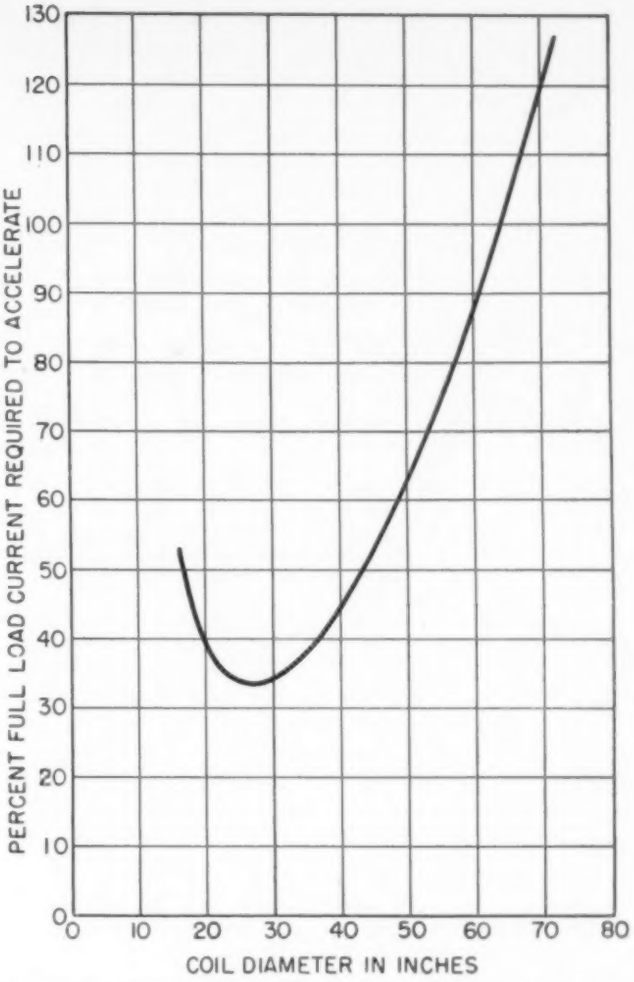


Figure 2 — Curve shows variation in accelerating load with coil buildup.

Comparing this figure to the previous calculation reveals that the accelerating load demanded by a full reel is 2.4 times that required for an empty reel. The manner in which the accelerating load varies over the coil buildup is shown by Figure 2. This effect is more noticeable for a direct connected reel than for one which has a reduction gear because the relative change in inertia is greater. For the selected example, the inertia change is 226,700/4700, or 48.3/1. If the same reel were driven through a 2:1 reduction gear by the same motor, the full-reel inertia referred to the motor shaft would be

$223{,}500\times\left(\frac{1}{2}\right)^2+3100=58{,}900$ lb-ft., the empty reel inertia referred to the motor shaft would be $1500\times(\frac{1}{2})^2+3100=3475$ and the inertia change would be but 58,900/3475, or 17/1. If the inertia ratio is very small, the accelerating load may be greatest when the reel is empty but this is not common with present day, high speed mills. This problem of changing accelerating load does not enter directly into the selection of the reel motor rating because the motor inherently has greater commutating ability at full field than at weak field. However, its importance must be evaluated in terms of control equipment since a large variation in accelerating load demands improved inertia compensation circuits which are capable of recognizing and following this variation.

Since it is unlikely that any mill will accelerate with a full winding reel, it might be argued that the peak accelerating load previously calculated is fictitious. However, partial accelerations with a nearly full coil are not at all uncommon, and it is felt that the peak load as calculated is a sound basis for evaluating limiting conditions and selecting motor size.

While the foregoing discussion is based upon the winding reel, a similar condition exists when decelerating the feed reel or uncoiler and the limiting conditions can be calculated in a similar manner. A large ratio of peak to normal load may invite the selection of a motor or drag generator with special overload capacities, and such a choice might be justifiable, depending upon the economics of a particular situation. No generalizations can be made and to assure the selection of a balanced electrical drive all factors should be analyzed.

PULLER POWER REQUIREMENTS

Many temper mills are equipped with tension rolls or pullers located between the mill stands and the reels. These devices serve to increase the tension at the entry and delivery sides of the mill to values greater than those which can be obtained, or are desirable to hold, with the reels alone. Increased tension on the delivery side of the mill is desirable to improve shape, and on the entry side it is often impossible to obtain the tension required for proper tracking from the feed reel alone when the quality of the incoming coils is poor.

The usual puller consists of two steel rolls, one over the other, with the strip wrapping slightly less than 180 degrees on the top roll and slightly more than 180 degrees on the bottom roll. One or both rolls may be driven. If both rolls are driven, the tension on the mill side of the puller can be approximately three times the tension on the reel side, and if one roll is driven, the tension on the mill side can be approximately 1.73 times the reel tension before slipping occurs. These figures are derived from wire rope power transmission formulae and are based on a coefficient of friction of 0.18. They are not to be considered exact but rather as a reasonable basis for calculation. Based upon these figures, the maximum possible utilizable horsepower of the motor driving the bottom roll of a delivery puller would be 0.73 times the horsepower of the reel motor, and that of the top roll motor 1.27 times the horsepower of the reel motor.

Since, as previously pointed out, it may not be possible to put full rated reel horsepower into strip tension without exceeding maximum permissible momentary loads during accelerating, the multipliers should be applied to the maximum utilizable reel horsepower. Referring to the previous example, the maximum reel tension-horsepower is 484 and the corresponding puller ratings would be $0.73 \times 484 = 353$ hp and $1.27 \times 484 = 615$ hp. It can be seen that there is a sound basis for the selection of puller motors of different horsepower ratings in the ratio of approximately 2/1, and this practice has been followed in many cases. However, there are also compelling reasons for specifying duplicate motors, and drives so motored have proven entirely satisfactory.

In this instance, the selection of two 500-hp motors or of one 350-hp and one 650-hp motor would probably be equally satisfactory. The former choice would be preferable from the standpoint of machine duplication and mechanical simplicity, but the latter would probably permit slightly better utilization of available power.

Because it is usually felt desirable to hold a high value of tension at the delivery side of the mill, both rolls of delivery pullers are usually driven to obtain maximum multiplication of reel tension. Entry pullers, on the other hand, often have but one driven roll because there is no particular advantage in holding tension on the entry side of the mill to higher values than that required for proper tracking. High tension at this point will impose additional load on the stand motor which is already carrying rolling load.

Acceleration and deceleration peaks on puller drives are seldom of critical importance because the machine inertia is low. Puller rolls range from 18 to 30 in. in diameter. To handle 42-in. wide strip, the puller roll face will probably be not less than 48 in. Referring again to Table I and assuming 24-in. diam rolls, the Wk^2 of one roll can be calculated as $48 \times 63.86 = 3060$ lb-ft^2. Allowing 50 per cent of this value for roll necks and other mechanical parts, and a motor Wk^2 of 500 lb-ft^2 for the 350-hp motor selected above, a total Wk^2 of 5090 is obtained. Per cent accelerating current is calculated as follows:

$$\text{Rpm} = \frac{5650 \text{ fpm}}{24/12 \times \pi} = 898 \text{ rpm}$$

$$T = \frac{5090 \times 898}{308 \times 10} = 1487 \text{ lb-ft}$$

Full load motor torque at

$$1350 \text{ rpm} = \frac{350}{898} \times 5252 = 2050 \text{ lb-ft}$$

$$\text{Per cent load to accelerate} = \frac{1487}{2050} = 73$$

Assuming that the motor is fully loaded under steady state conditions the peak load will be 173 per cent, which is within the capabilities of the usual mill motor. If the 500-hp motor had been selected the per cent accelerating current would be reduced.

While accelerating peaks are not usually a problem they should be checked, since the possibility of excessive load does exist, particularly on entry pullers which are sometimes lightly powered as noted above.

MILL STAND POWER REQUIREMENTS

The power requirements for temper rolling have not been clearly defined and the intelligent selection of stand motors has been hampered by the lack of specific test data. In an attempt to throw some light on this subject, the authors undertook to make a series of tests in an effort to establish some usable information. Accordingly, a number of selected coils of various thickness and width were rolled in the two-stand mill shown in Figure 1 and careful records were made of current and voltage of all drives, tension between stands, size of strip, speed and Rockwell hardness in and out. Since Rockwell hardness is used by many operators to check their temper rolling operation, and since it is more

TABLE II

Complete Data and Calculations

	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭		⑮	⑯			⑰
Coil	Total amp FR+EP	Tension EP—S1	Total amp WR+DP	Tension S2—DP	Tension S1—S2	S2 Tension amp	S2 Total amp	S2 Rolling amp	S1 Tension amp	S1 Total amp	S1 Rolling amp	Total Rolling amp	Rolling hp at 5000 fpm	Strip		Tons/hr at 5000 fpm	Rockwell			Ton—Rockwell points/hr.
														Width, in.	Thick, in.		In	Out	Added	
1	610G	3600	875M	4180	4300	25M	580M	555	119G	660M	779	1334	965	31 3/16	0.0089	142	50	55	5	710
2	592G	3490	835M	3990	4000	2M	560M	558	87G	620M	707	1265	915	31 3/16	0.0089	142	50	56	6	850
3	617G	3640	935M	4470	9000	930M	1000M	70	910G	2030M	2940	3010	2180	31 5/16	0.0335	535	31	55	24	12850
4	710G	4190	1085M	5190	9000	783M	1100M	317	815G	2000M	2815	3132	2265	31 5/16	0.0335	535	35	59	24	12850
5	720G	4250	1290M	6170	9000	581M	1070M	489	805G	1800M	2605	3094	2235	31 5/16	0.0335	535	42	60	18	9640
6	720G	4250	1220M	5830	9500	754M	900M	146	890G	890M	1780	1926	1392	26 7/8	0.0250	343	48	62	14	4800
7	720G	4250	1220M	5830	9500	754M	1000M	246	890G	960M	1850	2096	1513	26 7/8	0.0250	343	45	63	18	6170
8	710G	4190	1210M	5790	9500	762M	1025M	263	900G	860M	1760	2023	1462	26 7/8	0.0250	343	43	62	19	6520
9	635G	3750	1120M	5360	7000	337M	700M	363	551G	640M	1191	1554	1123	26 3/16	0.0185	250	48	55	7	1750
10	840G	4950	1220M	5830	9500	755M	1150M	395	771G	960M	1731	2126	1538	25	0.0396	505	45	60	15	7580
11	845G	4990	1200M	5740	5000	152G	300M	452	2G	1720M	1722	2174	1510	25	0.0396	505	48	61	13	6570
12	600G	3540	740M	3540	3900	74M	550M	476	61G	620M	681	1157	836	31 5/16	0.0078	125	55	61	6	750
13A	587G	3460	785M	3755	4000	50M	375M	325	92G	580M	672	997	720	31 5/16	0.0078	125	52	57	5	625
13B	587G	3460	785M	3755	6000	461M	850M	389	431G	230M	661	1050	759	31 5/16	0.0078	125	52	57	5	625
14A	555G	3280	800M	3830	6200	487M	950M	463	495G	190M	685	1148	830	31 5/16	0.0078	125	52	57	5	625
14B	555G	3280	800M	3830	4000	35M	550M	515	122G	530M	652	1167	843	31 5/16	0.0078	125	52	57	5	625
15	.....	.....	.....	.....	.....	.....	.....	.....	Readings Unreliable	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16	600G	3540	760M	3630	5000	282M	675M	393	248G	680M	928	1321	955	28 7/16	0.0105	153	53	55	2	306
17	620G	3660	760M	3630	5000	282M	675M	393	248G	770M	1018	1411	1021	28 7/16	0.0105	153	50	55	5	765

Notes: Circled numbers are cross reference with sample calculation. Coils 13A and 13B are parts of the same coil rolled with different tension between stands. Ditto coils 14A and 14B.

readily measurable than elongation, an attempt has been made to relate the power requirements to the rise in Rockwell hardness.

The essential test data that were obtained are given in columns 1, 3, 5, 7, 10, 14 and 16 of Table II. The data were analyzed as shown in Figure 3 by calculating the tension loads at each mill stand and subtracting these from the total loads to obtain the actual rolling load in horsepower. For simplicity all calculations are based on operation at rated top speed of 5000 fpm.

The amount of material being rolled and the degree of cold working as indicated by the change in Rockwell hardness was expected to bear some relation to the rolling power. To establish such a relation, the amount of material was expressed in tons per hour, this figure was multiplied by the number of Rockwell points added in the mill, and the resulting values were plotted against the rolling horsepower. The results of this procedure are shown in Figure 4. It was hoped that a simple constant of proportionality would result, but the plotted points indicate an equation of the following form:

$Hp = 750 + (0.121 \times \text{tons per hour} \times \text{Rockwell rise})$

In order to obtain an equation which is generally applicable, the speed must be factored out and this can be done in the following manner:

$$Hp/fpm = \frac{750}{5000} + (0.121 \times \text{tons per hour per fpm} \times \text{Rockwell rise})$$

Since tons per hour = sq in. cross section × fpm × 0.102

Tons per hour per fpm = sq in. cross section × 0.102

and $0.121 \times$ tons per hour per fpm $= 0.0123 \times$ sq in. cross section.

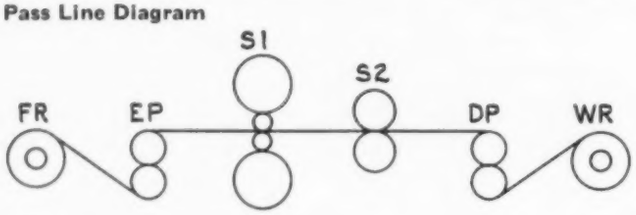
Therefore $Hp/fpm = 0.15 + (0.0123 \times \text{sq in. cross section} \times \text{Rockwell rise})$

and

$$Hp = fpm\left[0.15 + (0.0123 \times \text{sq in. cross section} \times \text{Rockwell rise})\right]$$

Figure 3 — Sample calculation is here illustrated. Sketch shows pass line diagram.

Pass Line Diagram



Test Data

① FR Ampere 420G	① EP Ampere 300G	⑩ S1 Ampere 960M	⑦ S2 Ampere 1000M	③ DP Ampere 660M
⑫ WR Ampere 560M	⑤ Tension S1-S2 9500	⑭ Strip W x T $26\frac{7}{8}$ x 0.025	⑯ Rockwell In 45	Out 63

M denotes motoring amp, G denotes generating amp

Assumptions:

Machine efficiency = 90 per cent mill speed 5000 fpm at 600 volt

$$\text{Tension motoring} = \frac{\text{Amp} \times \text{Volt}}{746} \times \frac{33{,}000}{\text{fpm}} \times 0.9 =$$

$$\left(\frac{600 \times 33{,}000 \times 0.9}{746 \times 5000}\right) \times \text{Amp} = 4.78 \times \text{Amp}$$

$$\text{Tension generating} = \frac{\text{Amp} \times \text{Volt}}{746} \times \frac{33{,}000}{\text{fpm}} \times \frac{1}{0.9} =$$

$$\left(\frac{600 \times 33{,}000}{746 \times 5000 \times 0.9}\right) \times \text{Amp} = 5.9 \times \text{Amp}$$

Calculations:

② $\text{Tension}_{EP\text{-}S1}$ = (FR amp + EP amp) x 5.9 = (420 + 300) x 5.9 = 4250 lb

④ $\text{Tension}_{S2\text{-}DP}$ = (WR amp + DP amp) x 4.78 = (560 + 660) x 4.78 = 5830 lb

⑥ S2 tension load = ($\text{Tension}_{S1\text{-}S2}$ — $\text{Tension}_{S2\text{-}DP}$) x $\frac{1}{4.78}$ = (9500 — 5830) x $\frac{1}{4.78}$ = 754M amp

⑧ S2 rolling load = Total amp — Tension amp = 1000 — 754 = 246M amp

⑨ S1 tension load = ($\text{Tension}_{S1\text{-}S2}$ — $\text{Tension}_{EP\text{-}S1}$) x $\frac{1}{5.9}$ = (9500 — 4250) x $\frac{1}{5.9}$ = 890G amp

⑪ S1 rolling load = Total amp — Tension amp = 960 — (—890) = 1850M amp

⑫ Total rolling load = 246 + 1850 = 2096 amp

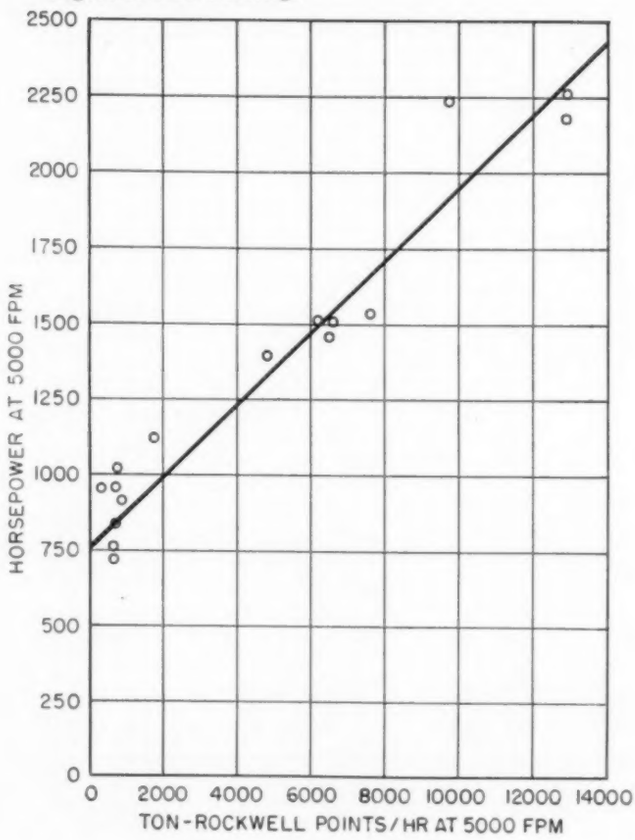
⑬ Rolling hp at 600 volt = $\frac{2096 \times 600}{746}$ x 0.9 = 1513 hp

⑮ Tonnage rate = W x T x fpm x 0.102 = 26.875 x 0.025 x 5000 x 0.102 = 343 tons/hr

⑰ Ton — Rockwell points/hr = Tons/hr (Rockwell out — Rockwell in) = 343 (63 — 45) = 6180

Circled numbers are cross reference with complete calculations.

Figure 4 — A straight line can be used to show the variation between the horsepower at 5000 fpm and the degree of cold working.



Sufficient data are not available at present to check the validity of this equation for other mills. The only satisfactory explanation for the constant, 0.15, is that it represents the power required to overcome mill bearing friction and to rotate the crowned work rolls under operating conditions with screw pressure sufficient to flatten the rolls at the point of contact. It is possible that roll grinding practice and mill bearing characteristics are generally similar enough that the value of the constant will not be subject to extreme variation.

The constant factor in this equation is probably a characteristic of cold rolling which is apt to be negligible when large drafts are being taken, rather than a characteristic peculiar to temper rolling.

A comparison of the rolling loads as indicated in columns 8 and 11 of Table II reveals the interesting fact that about 75 per cent of the rolling load is usually found in stand No. 1. While this is not universally true, it appears to represent the trend of present day practice and should be considered in selecting the motor ratings. However, it should also be noted that the distribution of the total motor load is dependent upon the tension between stands. This is clearly shown by comparing columns 7 and 10 of Table II for coils 13A and 13B. Thus the operator may be able to distribute total load equitably between stands No. 1 and No. 2 even though the distribution of rolling load varies considerably. Another way of stating this fact is to say that power may be transferred from stand No. 2 to stand No. 1 by means of strip tension when stand No. 1 tends to become overloaded by rolling load. The maximum tension that the strip can stand will naturally limit the horsepower that can be transferred in this manner. Tensions as high as 50,000 psi are possible with good strip that is free of edge cracks, but satisfactory strip can be rolled with tensions as low as 10,000 psi.

In general, temper can be obtained either by screw pressure or by tension. Since screw pressure can be used to divide the rolling load in any desired proportion, and tension between stands can be used to divide total motor load, a satisfactory adjustment of the mill for rolling a given strip to a given temper can usually be reached if the total horsepower of the two stands is sufficient to supply the rolling load.

Based upon average rolling practice, it would seem best to calculate motor ratings for 75 per cent rolling load in stand No. 1, 25 per cent rolling load in stand No. 2 and tension between stands equal to 20,000 to 30,000 psi. Let us assume that it is desired to roll 0.0088 × 42-in. strip at 5650 fpm to a maximum Rockwell rise of 20 points. The total rolling horsepower would be:

$$Hp = 5650\left[0.15 + (0.0123 \times 0.0088 \times 42 \times 20)\right] =$$

$$5650\ (0.15 + 0.091) = 5650 \times 0.241 = 1360 \text{ hp}$$

of which, 1020 hp would be assigned to stand No. 1 and 340 hp to stand No. 2. Winding reel tension was previously assumed to be 7500 psi and a reasonable value of tension multiplication in the delivery puller would be 2.5, giving a tension of 18,700 psi at the delivery side of stand No. 2. Assuming that tension between stands is 25,000 psi, the net tension on stand No. 2 is 6300 psi or 2330 lb. The tension load on stand No. 2 is therefore:

$$\frac{2330 \times 5650}{33{,}000} = 400 \text{ hp}$$

giving a total load on stand No. 2 of 740 hp.

With an average value of feed reel tension, and a tension multiplication of 1.5 in the entry puller, the total tension at the entry side of stand No. 1 might be assumed as 7500 psi. The net tension would, therefore, be 17,500 psi or 6480 lb, giving a tension load of 1090 hp on stand No. 1. This horsepower is delivered to stand No. 1 by the net strip tension and the net horsepower required of the stand No. 1 motor is, therefore, nearly zero for the assumed condition. However, when rolling poor strip, it may not be possible to exceed 9000 or 10,000 psi tension between stands, and under these conditions stand No. 1 motor would have to supply 900 hp of rolling load. If the tension were thus reduced, stand No. 2 would be relieved of tension load and would be able to take some of the rolling load from stand No. 1. Assuming that the tension at the delivery side of stand No. 2 is reduced to the same value as the tension between stands, screw pressure could be used to divide the load at 450 hp per stand by taking 44 per cent of the rolling load in stand No. 2 and 56 per cent in stand No. 1. It is not always desirable, however, to take such a large percentage of the rolling load in stand No. 2, and it would probably be unwise to provide less than a 750-hp motor for stand No. 1.

The possibility of holding as much as 40,000 psi tension between stands also exists and this condition should be investigated. As an extreme, the delivery puller might be able to multiply winding reel tension by 3.0 giving a tension of 22,500 psi at the delivery side of stand No. 2. The net tension of 17,500 psi on stand No. 2 would result in a tension load of 1100 hp. Even if the rolling load could be reduced to zero, it would seem unwise to select a motor of less than 1000 hp if this is an infrequent condition, or 1200 hp if it is a frequent condition.

A reasonable selection for these mill drives would be 750 hp for stand No. 1 and 1000 hp for stand No. 2. If much operation at a low value of tension between stands is contemplated, it might be advisable to select a 1000-hp motor for stand No. 1. It should be noted that, for rolling the specified product, stands No. 1 and No. 2 are not simultaneously loaded to capacity. This suggests the possibility of rolling a heavier than normal product with screws and tensions adjusted to equalize the total load between stands. For instance with 6900-lb tension at the delivery side of stand No. 2, 2800-lb tension at the entry side of stand No. 1, and both stand motors developing 1000 hp, a total of 2700 hp is available for rolling load. With this total horsepower available, a strip 0.0335 in. × 42 in. could be given a Rockwell rise of 19 points. With the rolling load divided 25 per cent in stand No. 2 and 75 per cent in stand No. 1, the tension between stands would be 8800 lb or 6250 psi.

Before making the selection of motor ratings, it is necessary to consider, as always, the accelerating peaks. Assuming four high mill stands with 48-in. face, 52-in. diam backup rolls, and 16-in. diam, direct driven work rolls, the mill Wk^2 and accelerating load can be estimated as follows:

Wk^2, two backup rolls, referred to work rolls =

$$(2 \times 48 \times 1407) \times \frac{16^2}{52} = 12{,}900$$

Wk^2, two work rolls $= 2 \times 48 \times 12.61$	= 1,180
	14,080
Plus 30 per cent for roll necks, etc.	4,200
	18,280
Typical motor Wk^2	1,500
	19,780 lb-ft^2

$$\text{Motor rpm} = \frac{5650}{16/12 \times \pi} = 1350 \text{ rpm}$$

$$\text{Accelerating torque} = \frac{19{,}780 \times 1350}{308 \times 10} = 8670 \text{ lb-ft}$$

$$\text{Motor full load torque} = \frac{1000}{1350} \times 5252 = 3900 \text{ lb-ft}$$

$$\text{Per cent accelerating load} = \frac{8760}{3900} = 225$$

This excessively high value strikingly illustrates the impracticality of building high speed temper mills with very high accelerating rates. The stand motors, when selected on the basis of tension and rolling loads, are often too small to produce the desired accelerating torque, and it is not economically feasible to supply motors of the required horsepower. If, in the example followed in this paper, we were to select motors with conventional overload ratings, the stand motors would be rated:

$$\frac{(2.25 + 1.00) \times 1000}{1.75} = 1850 \text{ hp}$$

minimum, or approximately 85 per cent larger than required to develop the expected running loads. A better alternative might be to increase the accelerating time to 20 seconds which would reduce the accelerating load to 113 per cent and the required motor rating to:

$$\frac{(1.13 + 1.00) \times 1000}{1.75} = 1200 \text{ hp}$$

Such an increase in accelerating time would also permit the selection of more reasonable reel motors.

GENERATOR SELECTION

Before the generator capacity can be selected, it is necessary to decide the basic electrical circuit. The use of a single generator with common bus and boosters for the individual drives has been common practice in the past. There is a developing trend toward the use of individual generators for cold mills but the desirability of using this system for temper mill drives is questionable. First, there is no real need for the flexibility afforded by individual generator drive because the drafts taken in temper rolling are so small that all drives run at substantially the same speed at all times. Second, the total power expended in temper rolling is relatively low, and with all drives fed from a common bus, full advantage is taken of pumpback power, the total load imposed on the generator is limited to rolling load plus losses and minimum generating capacity is necessary.

With individual generators, each generator must be capable of supplying the maximum load of the drive it supplies regardless of whether that drive is motoring or generating. This naturally results in a total generator capacity considerably greater than that required to supply the total net load. If all of the generators are driven by a single a-c motor, advantage can be taken of generator diversity and the motor can be approximately the same size as for the single generator. However, the multi-unit set will still have an appreciably greater cost even considering the higher speeds possible with the smaller generators.

As an example, the temper mill of Figure 2 is operating satisfactorily with a common bus system supplied by a 1750-kw generator driven by a 2450-hp synchronous motor. The total motor horsepower connected to the generator bus is 3135. With an individual generator system, six generators with a total capacity of not less than 2500 kw would be required.

Naturally, a complete cost comparison cannot be made without considering the boosters which are necessary for the common bus system and the difference in the control equipment required. When all of these factors are considered, a cost advantage in favor of the common bus system usually results.

In selecting generators, consideration must be given to peak loads as well as to normal loads, and if motor ratings have been calculated as described in this paper, the data will be available to do this. Where accelerating rates are high, oversize generators, or generators with special overload ratings may be necessary.

CONCLUSIONS

As mill speeds become higher, acceleration problems begin to assume paramount importance and require the careful selection of drives and control. It is interesting to note that the importance of low motor Wk^2 tends to become less as mill speeds increase, because the lower gear ratios naturally used do not reduce the machinery Wk^2 materially and the motor Wk^2 is a small percentage of the total. This tendency will be made clear by reference to the Wk^2 values used in the examples calculated in this paper.

A method of calculating the horsepower required for working the metal has been derived from test data. It appears that a good correlation exists between the horsepower and the change produced in Rockwell hardness, but additional data are required to confirm the accuracy of the method described. The form of the power equation suggests that a substantial percentage of the total is actually consumed without producing any change in the material being rolled.

The intelligent selection of drives for temper mills requires that serious consideration be given to the peak loads during accelerating and decelerating. The relatively small rolling loads involved lead to the selection of motors which do not have the ability to handle the large peaks demanded by high accelerating rates. A compromise must often be made either in accelerating time or in machine rating, and nothing but a serious economic study will reveal the direction in which the compromise should be slanted.

DISCUSSION

PRESENTED BY

R. M. PEEPLES, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

M. D. STONE, Manager of Development, United Engineering & Foundry Co., Pittsburgh, Pa.

V. E. SCHLOSSBERG, Assistant Chief Engineer, Inland Steel Co., East Chicago, Ind.

H. W. POOLE, General Electric Co., Schenectady, N. Y.

WILLIAM P. SMITH, General Electric Co., Schenectady, N. Y.

A. F. KENYON, Steel Mill Engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.

H. H. ANGEL, Electrical Engineer, Bethlehem Steel Co., Bethlehem, Pa.

R. M. Peeples: The data given by Smith and Butler are very interesting, particularly that which they made on the mill rolling and power problems. I think that is an area on which we really need facts.

On many points we find that this data is in agreement with what we have found. For instance, I would like to refer to the constant factor of 750 hp. This is the figure with which Mr. Smith treats frictional losses on the mill. This is comparable to friction loss data presented in the paper by Mr. Sellers in Figure 8.

As was shown in Figure 8 it is possible for this mill friction to get out of line. For what reason we are not sure. Probably the mechanical people can tell us a little more about that. But we do find that roll widths and roll surfaces apparently have an effect on this factor, so I think that in applying a friction factor to all mills you have to take into consideration the type of mill. Also, looking at Figure 8 and projecting the average loss of a 42-in. mill on that curve, we might determine that mill losses at 5000 fpm will turn out to be 800 hp. This is in agreement with the author's figures within 10 per cent, and it is rather remarkable that we come that close. Other mill operations also seem to agree with it within a certain variation.

The majority of mill rolling power is used in stand No. 1, although the actual ratio seems to be subject to a good deal of variation, and I would hate to say 75 to 25 per cent. The actual ratio used in all cases sounds like a good starting point.

Now we cannot question too greatly the author's observations regarding the determination of reels and coiler drives. I believe everybody in this business is pretty well in agreement in regards to the calculation of power for this type of application, and most of these methods have been used for some time.

I would like to comment on Mr. Smith's and Mr. Butler's description of what is involved in accelerating and decelerating large coils. We have been using this attack for many years, and are applying this theory to mills of many different widths. When contemplating rolling a narrow strip, obviously the WR^2 of the coil comes down as the strip narrows. Therefore the reel accelerating torque curve is actually a family of curves depending on the coil diameter and width.

The curve presented is for one width. As the widths change, the curve also changes because the volume of steel on the reel changes. If the compensation is set for only one width, it is going to be too high for narrower strip, and you may find breakage due to over compensation, and of course not enough compensation will be present for wider materials.

We have several installations in operation where both width compensation and diameter compensation are handled (by the operator for width and automatically for diameter), which appears to be a satisfactory way to tackle the problem. The necessity for its use depends upon the available torque and the material being rolled.

We were a little disappointed that the authors, Mr. Smith and Mr. Butler, did not give us a little more data on the characteristics of the mill on which their data was taken. We were left a little bit in the dark as to the diameter of the rolls, for instance. Now, if we assume that the mills are using a large roll on number two stand and a small work roll on stand number one, an 8 or 9-in. roll, we find the data that Mr. Smith and Mr. Butler presented a little hard to reconcile as applied to, say, a mill with 18-in. rolls.

If we use this data as presented, I am not sure we can apply it to the other type mills with the larger rolls. In fact, I wonder if we can even compare the points.

M. D. Stone: In connection with the papers, I thought it would be well to take a look at a type of tin plate temper mill that we built eight years ago, and which has been operating ever since at the Niles plant of the Republic Steel Corp. It is known as the unitemper mill. It has many objectives, but in keeping with the discussion this morning, I would like to point out the objective as far as power is concerned.

This is a mill in which two 2-high mills are built into a single housing. The primary objective is to create high inter-stand tension so that the strip is actually stretched above the yield point, which is of the order of 40,000 to 50,000 psi.

My comment briefly is this: In interpreting the data that has been presented, I am thinking of Figure 8 in Mr. Sellers', et al, paper which shows a figure 0.4 to 1.0 hp per in. per 100 fpm for a range of tempers up to T-6. Just making a rough transfer in figures, that would be approximately 4 to 10 hp-hr per ton. The data from the curve on the Weirton mill is a little more difficult to transfer quickly. It seems to show figures of around 11 to 12 hp-hr per ton.

The mill at Republic, which was started at 3000 fpm, and which was rebuilt three years ago for speeds up to 4000 fpm shows a range of horsepower of from 2.5 to 7.0 hp-hr per ton, indicating that the design and mechanical structure has a great deal to do with horsepower required. It is not only a temper rolling problem, but a thin strip problem, indicating changes in mechanical design and equipment as well as in the electrical engineering.

V. E. Schlossberg: Everybody is always talking about the high no-load value of a temper mill and I was going to say that nobody has ever done much about it. I know of the union temper mill. I do believe that people are doing something on no-load losses. They are listing them and trying to find out how to correct them.

In a two-stand temper mill, we have a feeding reel,

a tension device, a number one stand, a number two stand, a pulley and a winding reel. One of those units should operate as a pacer to determine the speed. I wonder which one of these units it should be and why?

R. M. Peeples: In answer to Mr. Schlossberg's question, "which one of the units should operate as a pacer to determine the speed," we do it both ways. For many years we used No. 1 stand and later we shifted over to No. 2. I believe it is a little easier to use No. 2 stand because the load of No. 1 goes in both directions. When it is pulled, it is a generator, and when it does more work it is a motor. It is a little bit easier to set the mill speed, and also to regulate it, if you use No. 2. I think most people are in agreement on that. We seem to line up anyway, although for many years we used No. 1 consistently. There are many mills operating that way.

I might also add on no-load characteristics that I think the builder of the mill might have a little bit to say about no-load characteristics. In some of the mills where we have found it is unusually high, there is nothing we can do about it.

H. W. Poole: All of the authors have done a lot of work in collecting their data and they have done a fine job in analyzing and presenting it. In my opinion, the two methods of approach which have been demonstrated are entirely complementary.

It is highly desirable to have actual power data available for use in determining the sizes of rolling mill drives. In addition, it is also desirable to check the results against existing drives on comparable mills.

The required accelerating torque may often determine the size of a drive selected for a temper mill. This is not usually the case when laying out a cold reduction mill. Tandem mills require so much rolling horsepower that the accelerating current is a lesser problem. Where a 5000-fpm reduction mill may have 4000 or 5000 hp per stand, the temper mill may have 1000 hp or less per stand.

The question of solid bus system versus individual generator system requires an entirely different analysis when considering tandem reduction mills and temper mills. Many people ask why we quite often recommend a solid bus system on temper mills. The answer is twofold. First, the booster generators for temper mills are relatively small and, therefore, require little space and are not a maintenance headache. The tandem reduction mill boosters are large in size and are required to carry heavy currents at low voltage. Secondly, it is quite often possible to use considerably less total kw in generating capacity on a temper mill with the common bus system because of the regeneration of power by the feed reels and pullers and even stand No. 1 in some cases on a two-stand mill. This regeneration of power is not a factor on tandem reduction mills. By and large it comes down to a question of economics. Either system will work satisfactorily on a temper mill, but quite often the solid bus system is more economical.

Member: I believe Mr. Smith had a two-stand mill. I would like to know why all the work should be done on No. 1 stand. We have a two-stand mill and I see little or no work ever being done on No. 1 stand.

William P. Smith: I believe it is probable that if your mill operation were analyzed it would be found that while most of the rolling work is being done in No. 1 stand, most of the power required to perform this work is coming from the strip tension between stands, thus reducing the load on No. 1 stand motor to a low value. This is a common occurrence, in fact, as Mr. Butler pointed out, it is often possible to operate a mill so that No. 1 stand motor is generating. In spite of the magnitude and direction of load on No. 1 stand motor, I have found in the analysis of many mill operations that the rolling load is usually divided between No. 1 and No. 2 stands in the approximate ratio of 75/25.

I do not want to leave the impression that I recommend such a division of rolling load. This is out of my province. It is only that my observations seem to indicate that a 75/25 division is common practice.

A. F. Kenyon: The authors of these two comprehensive papers on temper mills are to be commended for their presentation of test data and methods of power calculations to determine the ratings of the drives for the mill stands, entry and delivery pullers, and pay-off and winding reels of strip temper pass mills. Such data have been available for many years for most hot and cold reduction mills, but heretofore only meager data have been published for temper rolling. It is to be noted, however, that the rolling power may be small as compared to the power interchange due to the tensions in the strip at different points through the mill, and different operators have quite different ideas as to the required tensions, so that the correct powering of a temper mill cannot be arrived at with the same exactitude as other types of mills.

The authors of both papers have commented that if high rates of acceleration and deceleration are insisted upon, the drives—particularly for the mill stands and perhaps for the reels if extremely large coils are rolled—may have to be much larger in rating than necessary for the steady-state rolling and tension loads. A little comparison will indicate why this is so. For instance on a five-stand tandem cold reduction mill to operate at say 5000 fpm, the last stand motor may be of 4000-5000-hp capacity, and to accelerate to full speed in 10 seconds may require an accelerating torque of 75 per cent of the motor full load torque, in addition to the rolling load. Some recent temper mills have utilized the same heavy four-high roll stands as in the tandem mills, so that the inertias of rotating parts after allowing for the smaller drives and spindles are perhaps ⅔ to ¾ of the tandem mill stand inertia. However, as the authors have developed, the temper mill requires a motor of only 1000-1200 hp to carry the normal running load, and obviously this small motor cannot develop the torque to accelerate the temper mill at the same high rate as the much larger motor on the tandem mill. Whereas accelerating rates of 500 fpm/second or faster are fairly readily attainable on modern high-speed tandem mills, rates of even 250 fpm/second on a temper mill may be the determining factor in selecting the drive ratings, rather than the steady-state rolling and tension loads.

The authors of both papers have mentioned that each of the mill stand, entry and delivery puller, and pay-off and winding reel drives may be supplied from a separate generator, or all of the drives may be operated from a common bus with such booster generators as are required for the tension regulating control. Equally good control can be obtained with either system, but due to the relatively small ratings (as compared to a tandem

cold mill), and to the direct utilization of the large regenerative outputs from the pay-off reel and entry puller, so that the single generator may be much smaller than the combined ratings of all the drives, the common bus equipment frequently is more economical. However here again the accelerating loads rather than the steady-state rolling loads may determine the common generator rating as well as the individual drive ratings. A convenient method to total the accelerating loads on the common generator is to reduce all rolling, tension, and accelerating loads, to an ampere basis, as was done by the authors of the second paper, or inertias may be converted to a common basis of stored energy at the nominal maximum speed. For instance, calculations were made recently for a two-stand temper mill to operate at 4500 fpm maximum speed. The total capacity of the six drives was about 3500 hp, and study of the individual drives indicated that an accelerating rate of 250 fpm/sec could be met. Further it was determined that a generator of 1500 kw or even 1250 kw would be entirely ample to carry all expected steady-state total loads. However at 4500-fpm running speed, the total stored energy in all the rotating parts of the reels, pullers, and mills was 21,000 hp-sec, and to accelerate the entire mill at 250 fpm/sec, or from standstill to 4500 fpm in 18 seconds, would require the equivalent of 2350 hp or 1900 kw in addition to the normal steady-state total rolling load. On this basis, a 1500-kw generator seemed inadequate, and our recommendation was that the generator rating should be increased, or as a somewhat less costly alternative that the generator be specified to have 300 per cent rather than the usual standard 200 per cent maximum momentary load capacity to enable carrying up to 240 per cent of its rating during the accelerating period.

H. H. Angel: I enjoyed the papers very much. The horsepower data for a large number of mills was of interest. The subject of what horsepower to apply on various applications is a controversial one. Generally, the persons responsible for approving the size motors to be used have the recommendations of the mill builder electrical manufacturer, and sometimes what is in actual use in other mills.

Since there is a variation in the way steel is rolled, dependent upon metallurgical requirements and other considerations, I would like to ask the authors if they have found much difference in the tensions between the last stand of a mill and the winding drum, and also between roll pressures on various stands.

R. M. Peeples: It is difficult to reconcile the data between various plants. I would like to refer back to Table III which you can study more at your leisure. We have taken some observations from quite a few different mills. We find that the variation in tension between one and two, for instance, seems to run between 32,000 to 14,000 psi. We have given an average of 21,200. That is considered for a normal tin plate product with not too wide a variable. And the tension between the delivery tension and the last stand runs 9000 to 19,000 psi, which means an average of 13,100. Winding tensions average 6000 psi.

As far as figuring the definite roll pressure being used in this operation, we do not have much equipment on the various mills around the country to really indicate what the roll pressure is, but if you analyze the data in both our paper and the paper presented by Mr. Smith and Mr. Butler, you will find that the tensions in psi do not go up high enough to reach the yield point, so we are not getting actual reduction by the tension itself unless it is in small cross sections of the strip. It appears to us that the tension is of aid mainly in helping the rolling action along rather than anything else.

In referring to the paper by Mr. Smith and Mr. Butler, you will find a large reduction in the No. 1 stand at the Weirton mill. The roll setup and pressures on the No. 1 stand at the Weirton mill may be greatly different than at other mills. What is obtained at Weirton in the way of a reduction might be less someplace else. In general, it seems people do not try to run at too high pressure. It is rather the other way around. They get temper by a combination of correct rolling pressure on No. 1 stand and flatness from No. 2. You have to consider the shape of the product.

It has been suggested that there is a relation of tension between component mill parts in the order of unity for entry reel to entry tension, $\sqrt{2}$ for entry tension to No. 1 stand, $\sqrt{2} \times \sqrt{3}$ for No. 1 stand to No. 2 stand, $\sqrt{4} \times \sqrt{3} \times \sqrt{2}$ for No. 2 stand to delivery tension, and $\sqrt{4} \times \sqrt{2}$ for delivery tension to delivery reel. Taking the average tension of 21,200 psi between stands as $\sqrt{2} \times \sqrt{3}$, then entry tension to No. 1 stand tension $= \dfrac{\sqrt{2}}{\sqrt{2} \times \sqrt{3}} \times 21{,}200 = 12{,}300$ psi compared to our average of 13,300. Likewise entry reel to entry tension $= \dfrac{1}{\sqrt{2} \times \sqrt{3}} \times 21{,}200 = 8650$ psi compared to our average of 7730. No. 2 stand to delivery tension $= \dfrac{\sqrt{4} \times \sqrt{3} \times \sqrt{2}}{\sqrt{3} \times \sqrt{2}} \times 21{,}200 = 42{,}400$ compared to our average of 13,100 psi, and therein is the greatest variation in rolling practice between various mills. The average values indicate almost duplicate tensions on entry and delivery ends of the mill for two stand mills, while for single stand mills with delivery tension, the winding reels operate with about 25 per cent higher tension. The tension after the mill stand is about the same as between stands of a two-stand mill. We do not have sufficient data to discuss single stand sheet mills without tension device, but this is a subject on which future work must be done. In conclusion, we wish to refer to formulae I to N in the paper for the shortest method we know of to assemble all the data necessary to determine the power required to roll any desired product.

Member: I would like to give Mr. Angel a little bit of data. We have measured pressure on a temper mill for a number of years. On a single stand temper mill, we have measured pressures up as high as 100,000 lb per in. of width, and we have been getting higher tempers. On a two-stand tandem the pressure is 50,000 to 60,000 psi where tension is higher.

Coming to that union temper mill you spoke about, we do carry tensions above the yield point. The pressure is 2200 lb per in. That is the objective of the mill. That is the range.

SYMPOSIUM ON SOAKING PITS

. . . . AT SOUTH WORKS

By G. PRIMM

Assistant to Division Superintendent

South Works, United States Steel Co.

South Chicago, Ill.

▲ THE five primary mills at South Works are serviced by four batteries of soaking pits, one battery serving both the 40-in.-No. 1 and 35-in. mills. These soaking pits have been installed at various times between 1904 and the present, the older pits being revamped from time to time to improve their performance.

In general, all pits are regenerative and are now fired with primary cleaned blast furnace gas which may be enriched with varying amounts of natural gas. The highest enrichment used provides a mixed gas of about 140 Btu per cu ft. Blast furnace gas is used in the soaking pits at South Works as the plant has no coke ovens, but does have a surplus of blast furnace gas. Mixing stations were originally provided for each battery of pits for enrichment of the blast furnace gas with natural gas. Individual introduction at each hole is now used at all pits except those at the 44-in. mill.

The pits for the 40-in.-No. 1 and 35-in. mills were installed between 1904 and 1910. There are ten four-hole pits having 45.5 sq ft area per hole. The four holes of each pit have common air and gas reversing valves so that the distribution of the air and blast furnace gas between the four holes is dependent on the settings of saucer valves. The pits were originally fired with producer gas. Blast furnace gas was first mixed with the producer gas in 1931. Since 1935, when natural gas facilities were installed at South Works, a mixture of natural gas and blast furnace gas has been used. Forced air fans were later installed. The pits have relatively small checkers for both the gas and the air, so that enrichment of the blast furnace gas is required. The enriched gas averages about 120 Btu per cu ft with a maximum of 130 Btu. Heating rates for these pits are about 71 tons per M sq ft hearth area per hr with an average fuel consumption of 1.26 MM Btu per ton heated.

Ten of the pits for the 40-in.-No. 2 mill were built in 1904. Eight more were added in 1926. These are single hole pits, the first group having 54.6 sq ft hearth area and the latter 75.7 sq ft hearth area. Producer gas was originally fired. Blast furnace gas was added in 1926. Use of the producers was discontinued in 1935 with the installation of natural gas enrichment for the blast furnace gas. The pits have fair sized checkers for gas and air, but have no instrumentation or control. The average Btu of the mixed gas fired is about 120 Btu per cu ft. Heating rates for this battery average 76 tons per M sq ft per hr with an average fuel consumption of 1.54 MM Btu per ton.

The 54-in. and 44-in. mills were completed in 1930 and 1931 respectively. Seven two-hole pits of identical design were provided for each mill. They were built for producer gas and blast furnace gas firing. Use of the producers was discontinued in 1935 when natural gas was made available. The hearth area of these holes is 91.4 sq ft. With ample checkers for both gas and air, these pits will heat fairly well with straight blast furnace gas. Enrichment of the blast furnace gas for each hole to about 115 Btu per cu ft is provided at the 54 in. mill and is used when required. At the 44-in. mill a 115 Btu mixture is provided for all pits by a mixing station control. Automatic reversal has been installed on all of these pits, but no other control or instrumentation is provided. Heating rates and fuel consumption at these mills are not kept separated with respect to the original pits and the more recently installed controlled pits. Representative averages for all pits are as follows:

	Tons per M sq ft per hr	MM Btu per ton heated
54-in. mill	73	1.190
44-in. mill	87	1.160

The first automatically controlled pits were installed at the 44-in. mill in 1937. This installation consisted of three four-hole pits, 122.5 sq ft hearth area per hole. The pits were originally planned for blast furnace gas, producer gas, or natural gas firing. Producer gas has not been used. Natural gas was experimentally tried several years ago on one hole, but the operation was not very satisfactory or economically desirable. Until 1950 the pits were fired with a mixture of natural gas and blast furnace gas from the mixing station which serves all pits in this mill. However these pits have no checkers for preheating the blast furnace gas. Consequently, due to the resulting lower flame temperature, these pits were appreciably slower than the older pits. During the past year, equipment was installed for increasing the Btu mixture at these pits by adding more natural gas at each hole as desired. Natural gas-blast furnace gas ratio controls were installed, together with the necessary flow indicators, for enrichment of the blast furnace gas to a 140 Btu per cu ft mixture. With this enrichment, the heating rates are comparable to or slightly better than those obtained on the older pits. In addition to the above mentioned fuel-ratio controls, hydraulic fuel-air ratio and pit pressure controls are provided. Automatic time reversal of valves is also by hydraulic power. The

pit temperature control operates from a refractory target tube in the pit cover. Fuel and air flows and pit pressure are indicated.

In 1944 an additional pit was provided for the 54-in. mill. This pit was a three-hole pit with 147 sq ft hearth area per hole. Automatic controls were provided with separate introduction of natural gas to each hole. The major difference in the controls as compared to the pits at the 44-in. mill is that each fuel is separately controlled and the air for each fuel is also separately metered and controlled. A maximum enrichment to 130 Btu per cu ft is being used.

Recently, one of the original two-hole pits at the 44-in. mill was replaced with a four-hole pit, generally similar in design to the other four-hole pits. The major improvement over the older pits was the provision of larger blast furnace gas and air mains, together with adequate fan capacity, for a major increase in firing rates. Pit reversal was speeded up so that the fuel-off time at reversal was reduced from 40 seconds to 9 seconds. Checker temperatures are measured by radiation tubes sighting on the tops of the checkers. This temperature measurement is not only recorded, but is also used to control pit reversal by checker temperature difference, with maximum reversal time being set by timers for each side. Provision has been made for blast furnace gas enrichment with heavy fuel oil in the event of natural gas curtailment. The fuel oil is atomized with steam unit atomizers for each end. While initial operation has indicated that heating rates on this pit will exceed any previously obtained, no data are yet available on production rates, maximum firing rates or fuel consumption.

TABLE I

Summary — Soaking Pit Data — Chicago District — Youngstown Sheet & Tube Co.

Type of pit	Surface combustion	Surface combustion
Size of pit	6 ft 6 in. x 14 ft 6 in. 11 ft deep	7 ft x 14 ft 6 in. 11 ft deep
Range of ingot size, in.	24 x 36 to 32 x 46	24 x 36 to 32 x 46
Tons/hr per 1000 sq ft	72	72
Size of charge, tons	55	55
Type of bottom	Coke breeze	Coke breeze
Thickness of lining, in.	22½	22½
Thickness insulation, in.	8½	4½
Type of recuperator	Chapman-Stein	Fitch
Air pre-heat	....	500 F
Controls		
1. Ratio	None	Fuel-air ratio
2. Temp	None	Temperature
3. Pressure	None	Pit pressure
Per cent cold steel	10 to 15	10 to 15
Track time (average), hr	3.25	3.25
Fuels used	Coke gas No. 6 oil	Coke gas No. 6 oil

.... AT INDIANA HARBOR WORKS, YOUNGSTOWN SHEET & TUBE CO.

By H. B. HELM

Fuel Engineer, Chicago District

Indiana Harbor Works, Youngstown Sheet & Tube Co.

East Chicago, Ind.

▲ THE ingot heating capacity of the present 46-in. blooming mill consists of 11 rows of four-hole pits made of the following: eight rows of regenerative pits, and three rows of Surface Combustion pits.

The eight rows of regenerative pits are of the conventional type fired with 115 Btu mixed cold blast furnace and coke gas. When coke gas is not available, these rows are fired with straight blast furnace gas. All regenerative pits are equipped with automatic reversal and fuel air ratio controls.

One battery of Surface Combustion pits are of the older design and are equipped with Chapman Stein recuperators. These pits are 6 ft 6 in. × 14 ft 6 in. × 11 ft 0 in. deep and over-fired with two burners per hole, the waste gases leaving the pit through ports in the burner wall about 7 in. above the coke breeze bottom. Each pit has its own recuperator in which the waste gases make three passes while the primary air rises vertically upward through it and into the burner. In addition to this primary preheated air, cold secondary air is delivered to each pit by means of one blower for the four holes. Primary and secondary air are individually controlled. Practice is to use both when firing and when burning coke gas there is little or no luminosity to the flame.

The last two rows of pits are of the more modern design of Surface Combustion one way fired pits and were built about eight years ago. Each row consists of four holes, each hole being 7 ft 0 in. × 14 ft 6 in. × 11 ft deep and fired with one burner per hole. The waste gases from four holes of each row enter a common flue through which they pass to a Fitch recuperator. The combustion air is drawn through the recuperator by means of a hot air fan and delivered to the burners. Average preheat temperature of the air is 500 F.

Each hole is equipped with temperature, fuel-air ratio, and pit pressure control. The temperature measuring element is a radiation pyrometer located in the end wall opposite the burner and slightly below the top of the ingots. The pit pressure tap is located in the same wall.

Maximum Btu input per hole per hour is approximately 9,000,000.

All Surface Combustion pits are equipped for oil firing as well as gas. Present practice is to fire these one-way pits with oil during the winter, and changing to gas when natural gas becomes available to augment our supply of coke gas.

The average charge for all pits is about 55 tons. The ingots charged vary from 32 in. × 46 in. × 75 in. weighing 12 tons to 24 in. × 26 in. × 91 in. weighing 5.3 tons.

Steel heated varies from low carbon slabs to high carbon and alloy billets as well as bessemer steel.

The average fuel per ton for all pits, regenerative as well as the Surface pits is 1,300,000 Btu. Average tons heated per 1000 sq ft per hour is 72.2.

. . . . AT WISCONSIN STEEL WORKS

By R. N. POWEL

General Foreman Charge Heating

Wisconsin Steel Works, International Harvester Co.

South Chicago, Ill.

▲ THIS discussion deals with the new soaking pits at Wisconsin Steel Works. These pits are of the regenerative type. One battery of four holes was built in June, 1949; the second battery, also of four holes was built in November, 1950. The pit size is 13 ft in length, 5 ft 7 in. in width and the depth from the top of the curb to the coke line is 8 ft 6 in. The division walls between holes is 40 in. wide.

The inside walls of these pits are lined with silica sandstone blocks of a size that we have more or less standardized; 13½ in. by 9 in. by 4½ in. This is a convenient size for it may be laid up to give a nine-in. thick wall and may also be arranged to give 13½-in. tie-ins. The stone is laid in mortar composed of one part of chrome dust and two parts of fire clay. Three-eighths of an in. expansion is provided for between each joint. The arches are also laid up from silica stone cut to shape. The expansion in the arch is provided for by the use of a ⅜-in. thick pine board laid on each end of the arch against the skew brick supporting the arch. This board is allowed to burn out when the pit is fired. Vermiculite insulation mixed with fire clay is used as a protective coating for the arch while the pit lining is being burned in. We usually allow 60 hours for burning in a pit lining. Recently we have patched walls with new stone and, by applying a coating of insulation, have been able to bring the cold pit up to temperature in only a fraction of the usual time. The amount of spalling of the green stone used was not excessive.

We have done some experimenting recently with sidewalls built from rammed material, using refractory anchors for tie-ins. The thickness of this lining is also 9 in. Our experience to date would indicate that this type of lining is satisfactory for soaking pit walls even when ingots are leaned against the sides of the walls, as most of our ingots are.

Our pit lining below the slag line is laid up with 9-in. straights made of fire clay containing 70 per cent alumina. At this location, chrome brick were formerly used. The erosion from slag is very severe at this location, and neither the alumina nor chrome brick will withstand washing away and thus the stone wall above is undermined. We have found that the 70-per cent alumina brick has a greater resistance to erosion and we have slowed down the undermining of the stone wall above.

The bottom of the pit is filled with coke breeze to a depth of 12 to 14 in. The cinder is removed and fresh coke is added on a 48-hr schedule. The cinder is scraped out with a charger crane. It is dropped through two cinder holes and allowed to collect in dump boxes. When filled with cinder, the dump boxes are removed with a small electric lift truck.

The regenerators of our new pits are not very large; 7 ft 3 in. wide, 6 ft 4 in. in length. The available depth for checker brick is about 11 ft. We would have preferred to have had much larger ones if the space had been available. However, we have been able to overcome this disadvantage to a considerable extent by employing a rather short reversing cycle. The checkers are laid up with standard 9-in. first quality fire brick. The brick are laid to form 6½ × 6½ in. vertical flues and 6½ × 4½-in. horizontal flues. Our biggest disadvantage in having small regenerators lies in the fact that the velocity of the waste gases passing through is rather high. These gases pick up an entrainement of iron oxide which is deposited on the surface of the checker, which tends to lower the softening point of the checker brick. Unusual care must be exercised by the heater to see to it that the checkers do not become overheated. At the best our checkers will have to be renewed at least once a year, unless we can find a refractory superior to what we are now using.

Recently we have experimented with 70 per cent alumina brick in our regenerators. In one trial we used standard 9-in. straights for the body of the checker and topped off with 4 to 6 courses of 70 per cent alumina brick. In the other trial we put in the entire checker of 70 per cent alumina. While the length of time these checkers have been in service is not long enough to come to a definite conclusion as to whether or not they will be superior to fireclay brick, preliminary checks on the condition of the 70 per cent alumina checkers tends to indicate that we may expect a longer service life from them.

The automatic control equipment on each pit consists of a fuel input controller, fuel-to-air ratio controller, furnace pressure controller all of which are hydraulically operated; and an electrically operated automatic reversing control. Space is provided for on the panel boards to install temperature control if we should decide to do so at some future date. Some sort of temperature controller or at least a temperature recording device would be desirable from a standpoint of preventing overheating of the checkers.

Our fuel input controller automatically proportions the mixture of the two gases fired; blast furnace gas and coke oven gas. This controller is tied in with the

TABLE I

Summary — Soaking Pit Data — Wisconsin Steel

Type of pit	Regenerative
Size of pit	13 ft x 5 ft 7 in.
Range of ingot size, in.	21 x 23 18 x 34 23 x 26 inverted
Tons/1000 sq ft/hr	100 plus
Size of charge, tons	40
Type of bottom	Coke breeze, 12-14 in.
Thickness of lining, in.	9
Size of regenerator	7 ft 3 in. x 6 ft 4 in., 11 ft depth
Controls:	
1. Ratio	Yes
2. Temperature	
3. Pressure	
Per cent cold steel	15
Track time (average), hr	5
Fuels used	Coke oven gas Blast furnace gas
Btu per ton	1,060,000
Time to heat cold steel, hr	6-6½
Cover life, months	18-24
Per cent idle pit time	5

fuel-to-air ratio controller so that the desired amount of air for combustion is always available regardless of whether a lean or a rich mixture of gas is being used, or regardless of what quantity of total fuel is being used. When the heat is first charged, a rather rich mixture of fuel having a heat content of about 220 Btu per cu ft is generally used. As the heat comes to temperature, the heater cuts back on his fuel input and usually reduces the amount of coke oven gas in the mixture.

The furnace pressure controller functions in a slightly different manner than do similar controllers in most installations, in that the controller does not receive pressure impulses direct from the inside of the furnace. The impulse lines enter through openings in the regenerator roofs. It would have been possible to locate the impulse line centrally through the side wall of the furnace proper on the two outside pits of the battery, but this could not be done conveniently on the two inside pits; therefore, for the sake of uniformity it was decided to locate all impulse lines to enter the regenerator chambers. The only disadvantage to this was that it required two separate sets of impulse lines, one for each end, and these must be automatically reversed in sequence with the air and gas reversing valves. The pressure in the regenerator on the outgoing end is used to control the stack damper position. At the point where the impulse is taken, the pressure is slightly negative, but the relationship of this pressure to the pressure inside of the pit is fairly uniform (about 0.07).

The automatic reversing controller operates on a time cycle. It reverses the pit in a conventional sequence; first shutting off the incoming fuel, then reversing the air and waste gas valves; and then opening the fuel valve on the opposite end. The time consumed in making the reversal may be adjusted to suit the particular pit. For our type of pits this cycle consumes approximately 15 to 20 seconds. The timer may be adjusted so that there will be equal time between reversals, or it may be unbalanced by the heater if he so desires. The usual time between reversals amounts to about 8 minutes on the average, however, occasionally if the pit is not heating equally well from both ends, the heater might, for example, want to fire on one end for 12 minutes and on the other end for 4 or 5 minutes.

The covers on the new pits are 8 ft wide and 16 ft long. They are fabricated from 2 inch slabs; exceedingly sturdy and rigid. When setting in place on the pit almost the entire weight is brought to bear on the refractory over the arches at the ends of the pit; no structural support is necessary. When the pit is being charged or drawn the cover is lifted and moved by a cover carriage which spans the battery of four holes. The refractory used in these covers are either first quality fire brick laid to form an arch from all four sides, or rammed material suspended from refractory anchors attached to alloy hangers.

The refractory in the covers lasts from 18 to 24 months. The cover must be removed from the pit more frequently to patch the steel edges or end bearing plates that have been burned from exposure to flame.

Four sizes of ingots are heated in our pits, most of which are under five tons in weight. Our commercial grade of steel is delivered to the pits in 21 × 23-in. or 18 × 34-in. ingots. In the alloy grades, 23 or 26-in. round ingots are produced; poured in inverted molds with hot tops. It is necessary to lean all of the ingots against the pitwalls excepting the 18 × 34-in. size.

The average charge in our new pits is approximately 40 tons per pit. The rate of heating in terms of tons per 1000 sq ft of hearth area amounts to slightly over 100 tons per hour. Our fuel practice is about 1,060,000 Btu per ton.

About 15 per cent of the steel is charged cold. The time required to heat cold steel would be about 8 hr if the pit was charged full; however, we seldom charge full on cold steel unless we know that the mill is going to be down for several hours. The usual charge for cold steel is 80 per cent of a full charge of hot steel and in that case we are able to bring the charge up to rolling temperature in 6 to 6½ hours.

Our track time is rather long for small ingots of the size that we have. The steel is in the molds for an average of five hours.

When we speak of track time at our plant, we refer to the interval between the time all the steel is out of the open hearth furnace into the ladle until the last ingot is charged into the soaking pit.

The down time for repairs on a pit amount to about 5 per cent over a year's time. Our per cent idle time is not extensive; somewhat less than 10 per cent. Quite often, if steel is available to charge, and it usually is, the craneman will begin charging the ingots for the next heat before all of the ingots from the previous charge have been removed from the pit and rolled.

To summarize this paper briefly; we wish to state that we are well pleased with the performance of our new pits. We believe that a modern, fully controlled regenerative type of pit is best suited for an operation such as ours where we draw ingots at rates up to 40 ingots per hour. Other reasons for favoring this type of pit are:

1. High heating rate in a relative small pit area.
2. Low idle time because charging may be started before all of the ingots of the previous charge have been drawn.
3. Low downtime due to the simplicity of design, which results in low maintenance because repairs of a major nature can be made in a comparative short time.

. . . . AT INLAND STEEL CO., EAST CHICAGO, IND.

By P. C. SINGLETON

Superintendent Combustion Dept.

Inland Steel Co.

East Chicago, Ind.

▲ INGOT heating for the 46-in. blooming mill, Inland Steel Co., is done with 15 Salem circular pits, having a diam of 16 ft, rolling from ingot to slabs for our two strip mills. These pits are arranged in a single straight row, requiring a building about 800 ft long.

The covers are dished and sealed by sand. The cover cranes are equipped with electrical safety features. These cranes are slow moving, slow raising and slow lowering. Every four pits should have a cover crane.

The products of combustion leave the pit through a

TABLE I

Summary — Soaking Pit Data — Inland Steel Co.

Type of pit	Salem Circular
Size of pit	16-in. diam
Range of ingot size, in.	24 x 54 24 x 43
Tons/hr per 1000 sq ft	72
Size of charge, lb	200,000 182,000
Type of bottom	Coke braize
Thickness of lining, in.	22
Thickness insulation, in.	4
Type of recuperator	None
Air pre-heat	None
Size of regenerator	None
Air pre-heat	None
Controls:	
1. Ratio	
2. Temperature	Temperature
3. Pressure	Pressure
Per cent cold steel	20
Track time (average)	2 hr-55 min
Fuels used	Oil Coke oven gas
Btu per ton	1,350,000 9,000,000
Time to heat cold steel,* hr	9
Cover life, yr	10

*Minimum heating time varies with size and number of ingots charged, as specified by Metallurgical Department.

3-ft diam hole in the bottom center of the pit. A clean out door is provided in the flue near where the products of combustion leave the pit.

The products of combustion from three pits enter into a common flue, and from this common flue they pass through a fire tube boiler. The pressure within this common flue is controlled and maintained constant by boiler fan. The pressure within each pit is automatically controlled by its own damper.

The normal ingot charge for these pits is about 200,000 lb or 100 tons per pit. The heaviest ingot charged is 15 tons—26 × 54 × 90 in., the lightest ingot 8 tons, 26 × 36 × 72 in., with an average charged ingot weight of 11½ tons.

In charging and drawing, the fuel is put on the low setting before the cover is removed, by the cover crane operator.

These pits are equipped to fire with either oil or coke oven gas. An individual pit has to have either oil or gas for heating, it cannot be fired with both at the same time. A pit can be changed from oil firing to gas firing and vice versa without interfering with production, the change either way requires less than two minutes. The ability to change the fuel, fits in very nicely with the surplus coke oven gas from our coke plants.

Generally on Sundays they are fired with coke oven gas, and as gas is easier to handle than oil at the low rates, they are fired with gas on the down turns.

Each pit is equipped with 14 combination oil and gas burners, set on a 24 ft 7-in. diam circle. It is our opinion that a large number of small burners will give you more uniform heating than a small number of large burners. The inside opening of the burner ports are on a 20 ft 9 in. diam circle. In the original Salem pit, the burners were set to direct the flame at an angle of 23 degrees and 30 minutes with respect to a diametrical line. In our pits we increased this angle to 37 degrees and 30 minutes. This increased burner angle allows the flame to travel much farther before there is any possibility of any flame striking the side or edge of the ingot. In our pits, with normal operation, the flame does not impunge on the ingot.

Air at 16 oz pressure, is used to atomize the oil. The primary combustion air is also at 16 oz pressure.

The primary combustion air and the atomizing air are controlled by separate butterfly valves. The atomizing air is never allowed to fall below 9 oz pressure, as below this pressure, atomization of the oil is not complete. When firing gas, the air atomizing lines are used to bring the coke oven gas to the burners, the primary combustion air remaining the same for both oil and gas.

The Btu input per hour, when on gas, is approximately 22,000,000, when on oil, the Btu input increases to approximately 27,000,000 Btu per hour. The pits are equipped with automatic temperature and draft controls.

Nine of the pits are equipped with platinum-rhodium couples, six with radiation pyrometers. Due to the difficulty in maintaining the reflectors clean on the radiation pyrometer, and when the reflectors are dirty they show a lower temperature than the actual temperature, the heaters prefer the platinum-rhodium couples.

The temperature control has only two fuel settings, a high and low, with about a five to one turn down. When on high, the combustion is as near perfect as we can make it, when on the low setting the fuel is burned with considerable excess air.

When a heat is charged, the common practice is to set the thermocouple control temperature considerably above the rolling temperature. After the thermocouple has been on the higher temperature for 20 or 30 minutes, depending on condition of charged heat, the instrument is set back to normal rolling temperature.

These pits are grouped into three's and the products of combustion, from the three pits, pass through a fire tube boiler. This gives a better overall Btu efficiency, as compared to preheated combustion air, but it decreases your ingot output. Their yearly average Btu per ton is 1,350,000 with a net Btu per ton of 900,000 Btu.

These 15 pits turn out 120,000 finished tons per month, working the equivalent of 74 eight hour turns, charging 20 per cent cold steel and with a slow track time.

They will heat 72 tons per hour per 1000 sq ft of heating area.

DISCUSSION

PRESENTED BY

EMIL A. VIEROW, Supt. Fuel Dept., Youngstown Sheet & Tube Co., Youngstown, Ohio.

WILLIAM COLLINS, Wisconsin Steel Works, International Harvester Co., South Chicago, Ill.

G. PRIMM, Assistant to Division Superintendent, South Works, United States Steel Co., South Chicago, Ill.

F. A. CORBIN, Superintendent Fuel, United States Steel Co., Gary, Ind.

CHARLES HARKNESS, Assistant Fuel Engineer, Youngstown Sheet & Tube Co., East Chicago, Ind.

W. E. DITTRICH, Supt. Plant No. 2 Mills, Inland Steel Co., East Chicago, Ind.

R. N. BRYAN, Chief Engineer, Plant Dept., International Harvester Co., Wisconsin Steel Works, Chicago, Ill.

C. W. BRUCE, Assistant Chief Engineer, Republic Steel Corp., Chicago, Ill.

WILLIAM DOUGLAS, Assistant Supt. Combustion Dept., Inland Steel Co., East Chicago, Ind.

GRANT M. HERMAN, Soaking Pit Foreman, Keystone Steel & Wire Co., Peoria, Ill.

E. McGAUGHEY, General Foreman, Inland Steel Co., Indiana Harbor Works, East Chicago, Ind.

HENRY S. HALL, Morgan Construction Co., Worcester, Mass.

D. S. EWALT, Manager of Sales, Rust Furnace Co., Pittsburgh, Pa.

V. J. SALMI, General Foreman Mason, United States Steel Co., Gary Works, Gary, Ind.

GEORGE H. JOHNSTON, Superintendent, Republic Steel Corp., Chicago, Ill.

JOHN F. BLACK, Manager Continuous Casting Section, Freyn Engineering Div., Koppers Co., Chicago, Ill.

H. H. DINNEEN, Combustion Engineer, Rust Furnace Co., Pittsburgh, Pa.

EARL S. BUSH, Sales Engineer, Brown Instrument Div., Minneapolis-Honeywell Regulator Co., Chicago, Ill.

Emil A. Vierow: I would like to ask whether these figures on tons per thousand square feet of hearth area are average monthly operating figures or calculated heating capacities based on selected operating periods?

William Collins: In arriving at that figure for Mr. Powell's paper, we did not use that method. We have a monthly figure.

G. Primm: Average monthly figures were used.

F. A. Corbin: Our statistics are based on pit operating hours.

Emil A. Vierow: I should like to ask whether the fuel figures are on the basis of gross or net Btu.

William Douglas: Btu's reported are on a gross basis. Our average Btu per ton was 1,350,000 gross Btu's at Inland with a net, after steam credits have been given the pits, of 900,000 Btu's per ton.

G. Primm: Gross Btu figures were used.

William Collins: All Mr. Powell's figures are gross Btu's.

F. A. Corbin: All of ours are gross figures.

Charles Harkness: Our figures are net Btu's, I believe.

W. E. Dittrich: I wonder if we could get an expression as to what might be considered an optimum heating rate. Your figures seem rather high ranging from 70 to 100 tons per thousand square feet per hour. What is desirable and reasonable?

G. Primm: Actual average heating rates are affected by several variables such as track time, per cent of cold ingots, and delays in or drawing the pit. Consequently it is not generally possible to directly compare various pit installations.

R. N. Bryan: Is it not true that when you raise the number of tons you heat per thousand square feet, you must pour on the heat to do it? You can get the big tonnage out but you have to do it with fuel. You will find when you get a very large rate that you also get a pretty high Btu rate, is that not true?

Member: There is a noticeable difference between the old non-controlled pit; your scale loss may run 2 or 3 per cent, whereas on some of the pits with up-to-date controls and careful heating practice, there would be a loss of only 1 per cent.

C. W. Bruce: That is right, although I do think that a lot of your scale condition is determined by mill operators as to what they want. In some cases they like a heavy scale going to the oven. With the modern, new pits I think you can control to a large extent your mill people.

Member: This is directed to the Salem circular soaking pits. The author states that he has an air atomizer on the oil at about 16 ounce pressure and I was curious to know what type of burner it was, whether that was the correct pressure for that amount.

William Douglas: That is the correct pressure. It is a type 316 Hauck oil and gas burner.

Member: What is the pressure of the oil going into the pit?

William Douglas: We carry 70 to 75 psi on our oil header to the pits where it is reduced to 40 psi, and then control it with micro vernier valves to the burners until the heater sees fit to correct it so we get uniform distribution when we are firing on oil.

Grant M. Herman: I would like to ask Mr. Corbin if the 800,000 Btu's was an average fuel consumption for all kinds of pits or for the bottom fired pits alone.

F. A. Corbin: That was the average of all pits for one month.

Grant M. Herman: If you had taken the bottom fired pits alone, would the fuel consumption have been less than 800,000 Btu's?

F. A. Corbin: Slightly, yes.

E. McGaughey: On this production of a thousand tons produced per thousand square feet bottom space, the question in my mind is, "Just what the soaking pit men feel is a good figure for producing, just how many tons should we shoot at per thousand square feet of bottom?"

F. A. Corbin: In addition to what has been said here, first we have to determine what is the proper hearth area allowed. Different companies use different hearth areas for the same size pits. In a two-way soaking pit, you have to allow a certain distance through the center of that pit for combustion, and we find that various people allow various distances there. Also, in a top-fired pit, they consider the total area of the hearth, so it is pretty hard to say what is a good figure for it.

Emil A. Vierow: Recently we had occasion to make a study of various types of soaking pits in connection with needed additional capacity at Youngstown. We decided on large two-way top-fired Amco recuperative pits because this design would make possible getting the greatest tonnage of steel under cover for our particular layout, as well as provide a fast heating pit with good fuel economy. Our pits are not as yet in operation. However Mr. Hall of Morgan Construction Co., who had considerable experience with this type of pit while at Lukens Steel Co., is in the audience and perhaps would be willing to say a few words about it.

Henry S. Hall: I do not think it is necessary to go into a detailed description of the dual top fired soaking pits at Lukens Steel Co. because I presented a paper before the AISE, giving a detailed description of these pits. This paper is published in the 1945 Proceedings of the Association of Iron and Steel Engineers.

Incidently, I am not at Lukens Steel Co. anymore, and it is rather unfortunate that there is not some one here at this meeting from Lukens who could give you a much more up-to-date description of how the pits are working at the present time.

To sum up briefly the operation and general design of these pits, they are fired from the two opposite walls, the burners being located near the corners and firing at a slight angle toward the center of the pits. The exhaust gases are discharged through ports at the bottom of the pits underneath the burners, and these ports extend the entire width of the burner wall. They discharge into two separate recuperator chambers located on either side of the pits. We felt at the time that this method of firing gave us the best heating that it was possible to obtain for the type of charge that we had, which was all cold steel.

The pits were, of course, fully controlled from pit temperature and had fuel air ratio on both burners which we felt was worth the slight additional cost. Each pit had its own individual furnace pressure controller and damper, and therefore operated as a single furnace.

We installed 16 holes of this type of pit, the first eight holes being installed in the 206-in. mill at the beginning of the war, and these were primarily for heating large 90 × 40-in. ingots or slabs for the rolling of armor plate. Approximately a year after this first installation, the 112-in. mill was revamped and a new four-high stand with a width of 120-in. was added and, of course, it was necessary to add additional heating capacity. Eight more holes of pits which were slightly larger in cross section than the original ones in the 206-in. mill were installed in this new 120-in. plate mill.

All these pits were fired with either natural gas or Bunker C oil, depending upon the availability of either fuel.

In 1949 it became necessary to add additional heating capacity in the 206-in. mill for more normal size ingots.

Two holes were installed 14½ × 20½ × 12 ft deep, and these were designed to heat ingots ranging from 32 × 10 in. to 54 × 23 in. On the 54 × 23-in. ingots we could charge a little over 180 tons per hole. The average charge in these pits ran between 50 and 60 ton.

We did something on these two holes of soaking pits which may be of interest, in that we recirculated flue gas back into the pits.

Those of you who have used natural gas or Bunker C oil as fuel in the soaking pits know that when the fuel is modulated down to 2500 to 3000 cfhr of natural gas that you have a very short sharp flame regardless of what you do in the way of air to burn the fuel that is being introduced. It was my contention that by the introduction of recirculated flue gases, the volume of gases in the pit would be increased and we would have better heating by convection and conduction from this volume of flue gases than we would have by radiation from the very short flame that you normally obtain with only a few thousand feet of natural gas or a few gallons of oil. Since most of this heat must be transmitted to the steel by radiation, inasmuch as the volume of flue gases produced is very very small and therefore heat transfer by convection and conduction is practically negligible.

Comparing the results that we obtained on a weekly basis from Sunday to Sunday, which included all the light-up time and light-up fuel, we gained approximately one ton per hour and our Btu dropped about 100,000 Btu per ton. This was with an average of around 55 tons charged weight.

When we were experimenting with this recirculation, we tried, of course, all methods of doing it on the first two holes. We had complete control equipment on these holes so that we could vary the flue gas recirculation inversely as the total heat input to the pits, directly as the fuel input or hold it at some constant volume. That is, if we fired with natural gas, normally about 37,000 cfhr per hole, we could set the recirculation down to a minimum, and as the natural gas flow cut back, the recirculating flue gases increased until we were down to a minimum flow of around 4000 cu ft of natural gas per hour, at which time we had a maximum recirculation of flue gases. We found that we gained the most by maximum recirculation of flue gases all the time. As I recall, the fans we had on for recirculation would recirculate about 35,000 cu ft of flue gases per minute at 2 in. static pressure and approximately 800 F.

The fans required about 9 hp at maximum output to recirculate the flue gases so that this is rather a minor item as far as cost of operation is concerned.

In the latter part of 1949, we ordered another row of pits which were identical with this last row in the 206-in. mill, and on these included recirculation.

I do not believe that recirculation would be of any value where you are using 120 or 130 Btu gas, as you have enough recirculation so to speak due to the low Btu content of your fuel.

In our experimenting with the pits, we did find that if we started the pit out without recirculation that it would go along for six hours or so and you would have cold butts, which would normally require 1½ hours to get hot, but if recirculation were then put on, we could get them out in ½ to ¾ of an hour instead of the 1½ hours it would normally require. It was rather startling to us to find this to be true.

As to the operation of the pits at the present time, and whether they are or are not using recirculation of the flue gases, I will have to refer you to Mr. R. R. Fayles, fuel engineer of the Lukens Steel Co. at Coatesville, Pa. He will probably be able to give you a much more detailed description of whether recirculation is of any value or not.

D. S. Ewalt: Mr. Hall, did you use recirculation through the burner or separately from the burner?

Henry S. Hall: We recirculated on either side of the burner. There were two waste gas inlets. At first, the center line of the inlet was above the center line of the burner, but we found that there was so much velocity of this flue gas in there, it tended to blow the flame down on top of the ingots, so we moved it down so it was on the center line of the burner and the recirculation came in practically on the same center line as at fuel flow.

D. S. Ewalt: Back in 1930 when we were in the recuperative pit business, we tried recirculation of waste gases in the soaking pit. We put the gases through the burner, but it did not work.

V. J. Salmi: Our experience at Gary Works on high alumina brick on soaking pits on the side walls below the slag line has been very poor. We tried it on about a half a dozen pits, and we had to replace them with chrome brick in order to save the upper portion of the side walls. We had to take the high alumina out and put the chrome bricks back in before the side walls fell out.

William Collins: Regarding the high alumina brick, you probably have had more experience than we have; we have only been experimenting for about the last six months, and so far, we have had pretty good luck. May I ask, how long did you find they stood up before you had trouble?

V. J. Salmi: Four to eight months and then we had to replace them.

William Collins: It will be some time before I can answer you then on that matter as ours have not been in service that long as yet.

George H. Johnston: We do not have any trouble with the brick eroding in our soaking pit slag walls. Our soaking pits at Republic Steel South Chicago plant are large pits, each hole is 25 ft long, 8 ft 2 in. wide, and 15 ft deep. The bottom of the walls at the slag line are built of burned basic brick. We do not have any repairs to these walls.

John F. Black: I have some rather academic questions that might be answered among your capable authors. First, what is considered good furnace pressure in a soaking pit? Next, what is a good soaking pit atmosphere? What is good for steels in the common carbon range ordinarily heated in soaking pits? Next, what is the maximum flue gas velocity in soaking pit checkers? Finally, is 1200 F or more air temperature desirable with any fuels except blast furnace gas in ingot heating?

William Collins: I will try to say something about the first two. We find that a positive pressure, plus 02 seems to work out best for us. As to the air ratio, we try to operate at a 1 to 1. We set our theoretical base at that point. We set it for the amount of air that is required theoretically for the amount of gas and toward the end of the cycle, we might use a slight excess of air.

H. H. Dinneen: Concerning the pit pressure, it should be slightly higher than atmospheric at the top of the pit, say plus 0.01 to plus 0.02 in water column.

The fuel-air ratio should be held in range from a neutral atmosphere to about 5 per cent excess air.

For the richer fuels, coke oven and natural gas, I believe that the range of 1200 to 1400 F pre-heat temperature is adequate.

Henry S. Hall: I might add that we had indicated preheat air temperatures of 1600 to 1700 F with natural gas or oil. We had other pits that were down much lower than that, and we did not get as good fuel economy on the pits with the lower preheated air temperature as we did with these which showed the 1600 to 1700 F.

As to furnace pressure, we took every hole and set the furnace pressure on that hole where it ran best. We were interested in maximum performance, and had no rule of thumb to obtain this maximum performance, but set each hole individually to secure it.

I do think that the depth of the pit from the curb down to the bottom in all probability affects the furnace pressure reading that you obtain, as different depths of pit will give you different stack effects and, of course, different furnace pressures. I believe the deeper the pit that the higher furnace pressure will be required to afford good operation.

R. N. Bryan: I believe it is given by W. W. Trinks in his volume on "Industrial Furnaces." The value is 40 fps for flue gases.

Earl Bush: In measuring pressure, you can find all kinds of pressure in the pits depending on how well you compensate and where you measure.

F. A. Corbin: We have had lots of discussion on that subject. If the height of the instrument is the same as the height of your impulse pipe that goes into your furnace, we do not use them. We find we gain nothing by it. It is confusing. We have drafts around the pits and we have charts to prove that you can get anything you want, any kind of a reading you wish depending on the atmospheric conditions surrounding your pit. Now if you have an instrument in a boiler house down on the floor and you are taking your impulse three floors higher, you need a compensating pipe, but if the distances of the instrument location and the impulse location is the same, we find it is not necessary and it certainly helps the operator by not confusing him.

Charles Harkness: We use them and keep the compensated lines connected. The main reason is if there is an air current, then we have eliminated that effect, and we get better control.

William Collins: We use them.

William Douglas: We use them on 50 per cent of our installations, as Mr. Corbin outlined, where there is a difference in the vertical height and the temperature in the basement of the building and above. In others we do not use them if we find we do not need them.

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ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

NEW TUBE EXTRUSION PROCESS

at Babcock & Wilcox Co.

. . . . the new extrusion process enables the production of tubing from materials not possible before . . . . it thus opens a new field of tubing usage . . . .

▲ THE announcement issued late in 1951 that the Babcock and Wilcox Company had put into operation the first American extrusion press having the speed and other design features necessary to take full advantage of the Ugine-Sejournet hot extrusion process was the culmination of a long period during which more and more companies had become interested in this process. That the tubes produced from the first day's production were 18-8S (Type 304) and of salable quality made the announcement even more significant.

Since the beginning of the year, this plant has extruded Type 304, Type 321, Type 310, Type 316 and Type 446, pure molybdenum and pure titanium successfully. Noteworthy also was the extrusion of a tube from a round cornered square continuous cast billet, wherein a finished tube was produced from molten steel in just three operations. Successful continuous casting of steel was announced by the Tubular Products Division of the Babcock & Wilcox Co. in 1948.

THE PROCESS

The Ugine-Sejournet process, using glass as a lubricant, is the result of research and development work at the Persan, France, plant of Comptoir Industriel-d'Etirage et Profilage de Metaux, dating back to 1940. Over this period of years, the process was studied from the standpoint of the form of glass applied, the metal flow, the die analysis and design, the heating, and the desired speed and the required pressures of extrusion until it evolved as a practical method for the production of solid shapes and tubes by the extrusion process.

The most significant discovery, and the one which had a revolutionary effect on die life and surface quality, was the substitution of glass for the carbonaceous materials previously used as a lubricant. The glass, melting on contact with the hot steel, prevented seizing of the billet and tools, and insulated the tools from the heat of the billet. Of utmost importance in the rate of production, the excellent lubricating properties of the glass reduces the friction and makes it possible to increase the billet length. Once the number of extrusions per hour has been determined, the length and consequent weight of the billet determines the tons per hour.

To demonstrate how the lubricant affects the maximum length of billet which can be pushed, (Figure 1) illustrates an extrusion in which a definite amount of work done at the die requires a definite pressure in the steel at that point. The friction resulting from this pres-

Figure 1 — Friction is one of the important factors which limit the length of extrusion.

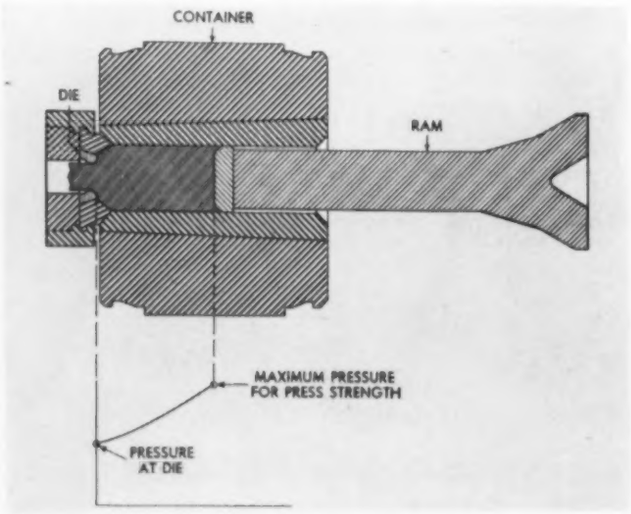
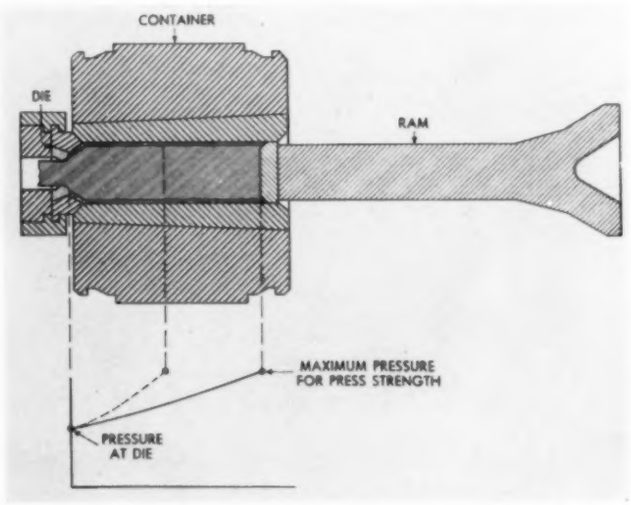


Figure 2 — With a good lubricant, pressure build-up is slower.



sure pushing out against the side of the container makes additional work necessary which requires additional pressure, and the additional pressure contributes to the friction force. With a poor lubricant, this cumulative pressure resulting from friction builds up to the full force of the press in a short length of billet. With a good lubricant, the cumulative pressure build-up is slower (Figure 2) and for the same amount of actual metal deformation and starting pressure, more inches of billet are accounted for before the full push of the press is used up. Additional inches (or pounds) of billet produced by each push means additional tons per hour of output, since the number of pushes per hour are negligibly affected by the billet length.

PRODUCTION OF TUBING BY EXTRUSION

In the extrusion of tubing, a hollow billet is confined in a container between the ram of the press and the die. Extending from the ram is a mandrel which passes through the billet and the die. As the ram moves forward (Figure 3), the metal is squeezed out between die and mandrel with the die determining the external contour and the mandrel the internal contour.

Although it is possible to produce the hollow billet by forcing the extrusion mandrel through it prior to extrusion in the same press, this method has limitations with regard to mandrel strength and stiffness. An alternate method used by CIEPM, and adopted by the Babcock and Wilcox Co. Tubular Products Division, makes use of a separate vertical press for piercing.

The benefits resulting from the type of separate piercing press used in this process are primarily concerned with the concentricity of the final tube. Obviously, this concentricity depends on the concentricity of the pierced billet just prior to extrusion.

In a separate press, it is possible to pierce a slightly oversized hole in the billet. Since this allows the use of a larger, and consequently stiffer mandrel, much less mandrel wander results at the far end of the pierced billet. The importance of using the large size diameter mandrel becomes apparent when it is recognized that the extrusion mandrel length to diameter ratio may be in some cases approximately 30-1.

The design of the press provides for compression of the billet to make it fill the container prior to piercing (Figure 4). This prevents eccentric piercing resulting from the billet lying off to one side of the container. When the billet is compressed to fill the container completely and the mandrel is accurately guided down the center with no tendency to be pushed off-center because of one-sided distribution of metal, the results will be a concentric pierced billet.

By the use of a separate piercing press, it is possible to place the billet in the extrusion press so that the first end pierced is placed farthest from the ram during the extrusion operation. At this point, the extrusion mandrel is flexible and will need convergence of concentric metal to hold it on center. As the ram approaches the die, the effective length of mandrel becomes less and its stiffness will provide a corrective effect on concentricity.

Thus, there are three separate concentricity correctives resulting from the use of this piercing press:

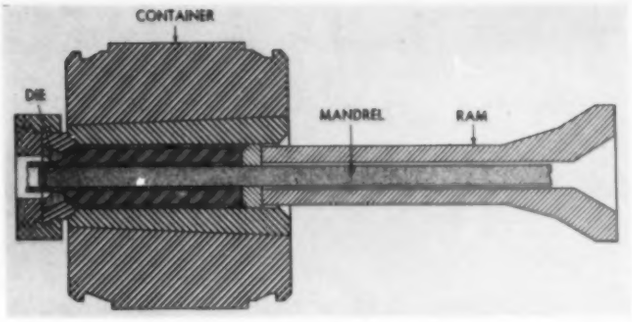


Figure 3 — In extruding tubes a mandrel is used.

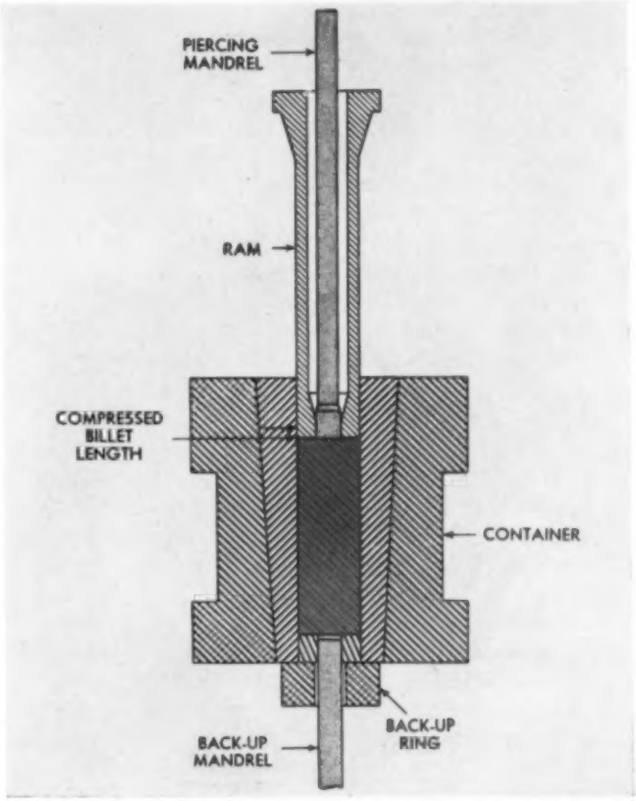
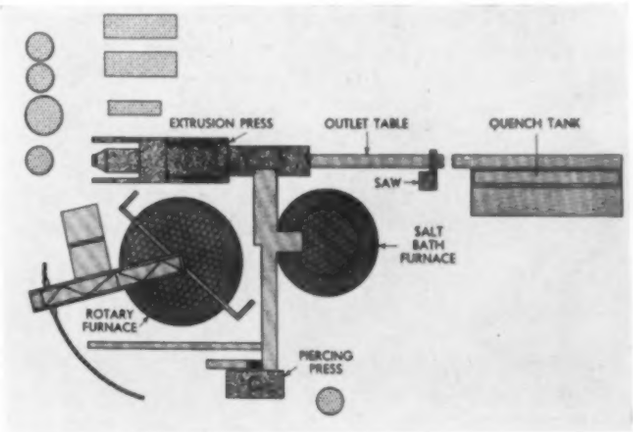


Figure 4 — The use of a separate piercing press enables the production of more accurate tubing.

Figure 5 — This arrangement was specifically designed for the production of solid and tubular shapes.



1. Pre-compression of the billet fills the container and prevents random off-center displacement of the billet and consequently the mandrel.
2. The stiffness of the oversized piercing mandrel gives more concentric piercing throughout the entire length of the billet.
3. Placement of the pierced billet in the extrusion press so that the very accurately pierced top end is extruded first when the extrusion mandrel is long and not stiff enough to hold center without the convergence of concentric material to help it.

The arrangement of the plant specifically designed for the production of tubular or solid shapes is shown in Figure 5. The billets are charged into a rotary hearth gas-fired furnace. After heating, if they are to be made into tubing, they are rolled across a "glass-pickup" table to the piercer charging device, or if they are for solids they by-pass the piercing operation and go directly to the salt bath furnace. The piercing is done with glass interposed between billet and piercing mandrel and depending on analysis, either with or without glass between the container and the billet. The piercing operation consists of pre-compression (Figure 4), piercing to within an inch of the cylinder bottom which is closed by a back-up mandrel and finally completing the pierce when the back-up mandrel retreats.

The pierced (for tubes), or unpierced (for solids) billet is charged into a metal basket which supports it in a rotary salt bath furnace (Figure 6). A hook on the surface of a large drum lowers the basket onto a carrousel support, and a cam-type surface on the drum rotates the carrousel forward and indexes the next basket into position where the hook will be in perfect position to lift it from the bath. After circling through the furnace, the basket is lifted out by the same drum and the billet discharged into a trough on a transfer car to the extrusion press.

The transfer car has an inclined surface on which a fiberglass mat is placed. As the car travels toward the extrusion press, the billet is raised out of the trough and rolled down the inclined plane fusing to the fiberglass mat and picking it up (Figure 7). When the transfer car reaches the end of its travel, the billet has rolled into a trough at the front end. The trough lines up with the container bore, and the billet is automatically pushed into the container.

Previous to this time, a fiberglass "sock" has been slipped over the mandrel (Figure 8) and a glass cartridge placed against the die. With the mandrel lubricated by the fiberglass "sock", the die lubricated by the cartridge, and the container lubricated by the glass picked up by the billet in passing across the transfer car, metal to metal seizure is prevented on all surfaces.

The actual extrusion takes place in from 2 to 4 sec, yielding a piece from 20 to 60 ft long depending on the size of billet and area of extruded section. The tube may be cut into shorter lengths on a hot saw and either quenched or rolled onto a cooling bed, depending upon analysis.

EQUIPMENT

The gas-fired rotary hearth furnace used for providing piercing temperature to billets for tubing, or preheat temperature to billets for solid extrusion, has a 23 ft hearth diam and a heating capacity of 5 tons of steel per hour from room temperature to 2250 F.

The 500-ton vertical piercing press has containers ranging up to 8 in. in diam. The stroke on this press is 34 in., which is enough to supply a 28-in. pierced billet to the extrusion press. After piercing, the container of the press can be shifted either under the piercing cylinder or out over a strippling cylinder where the pierced billet is pushed out and the next solid billet is received.

The rotary salt bath furnace used for reheating pierced billets and for completing the heating of the billets to be used for solid extrusions is rated at 5 tons of steel per hour from 1600 to 2250 F. It is powered by six 150-kw, 3-phase transformers which are switched on and off by automatic temperature control. The purpose of salt bath heating is to provide the extrusion press with billets as nearly scale free as possible.

The 2500-ton extrusion press has containers to handle up to 8-in. billets. The unusually long stroke of the main ram is 100 in. to allow a billet 28-in. long to be placed in front of the container before the start of the stroke. One feature of the Ugine-Sejournet process is a very fast extrusion stroke which minimizes tool heating. The press is designed with a prefill speed of 21-in. per sec and a possible power stroke speed of 6 in. per sec. The press operates on 3600 psi—water supplied from the two air-water accumulators, one for the supply of the main cylinder, and the second for the supply of auxiliaries and also the piercing press. The purpose of the divided supply is to provide variable main ram pressure if the occasion should arise.

METALLURGICAL ASPECTS

The extrusion process opens up a whole new horizon for the production of seamless tubing and solid shapes from the more refractory stainless steels and the highly alloyed and high melting point metals. While many of the more common austenitic and ferritic stainless steels can be produced by the rotary piercing process, there are mechanical forces in rotary piercing which prevent the piercing of the less plastic steels and metals. Through extrusion a large and important field of unpiercable alloys suitable for certain temperature uses with greatly improved creep properties and other alloys with greatly increased resistance to corrosion will now for the first time become available as tubing.

The extrusion process has been used on stainless steels, on both hydraulic and mechanical presses, in Germany, Britain and the U.S.A. Usual practice in these instances has been to use graphite or carbon-containing lubricants on the dies and tooling with the result that carburization has been a problem. The Ugine-Sejournet process, with the glass lubricant, has solved this difficulty and has made the operation much more practical from the standpoint of American production standards. Extrusion ratios have been greatly increased by use of this process.

Numerous highly alloyed steels not readily procurable in seamless tube form may be made available by this new process, including many unbalanced compositions.

The process is adaptable for the stainless bearing steels, types 440-A, B and C and the several varieties

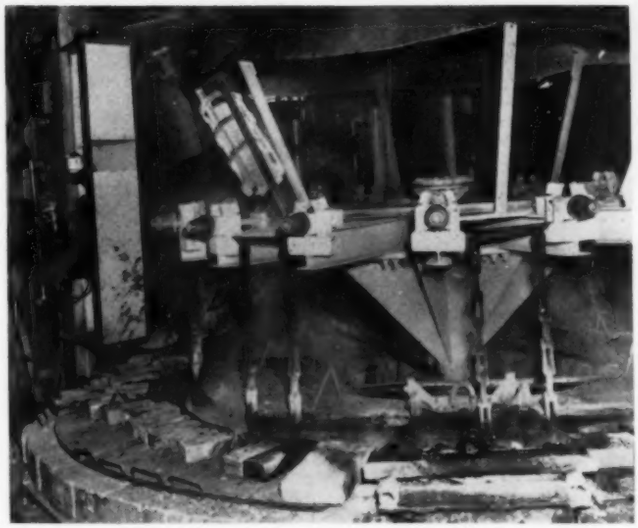


Figure 6 — The billets are heated in a rotary salt bath furnace.

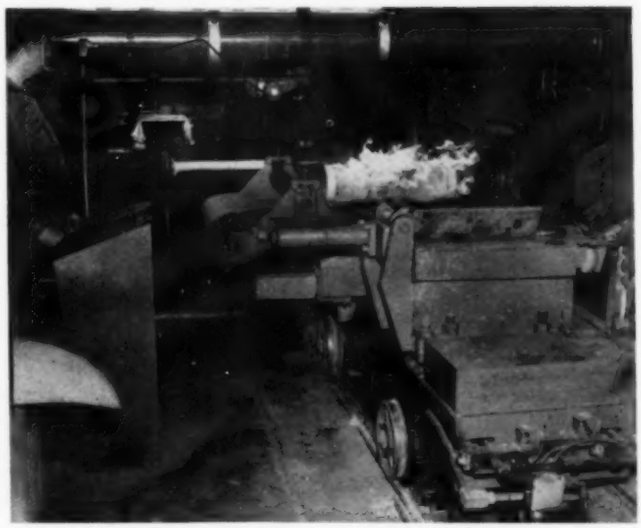
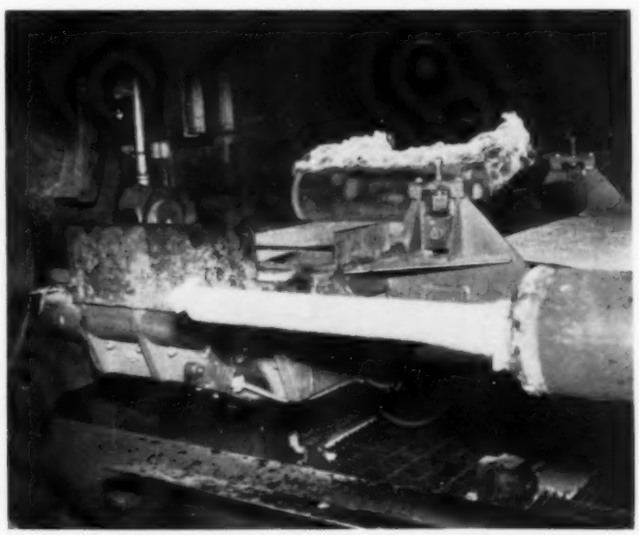


Figure 7 — The billet fuses to a fiberglass mat on a transfer car.

Figure 8 — Glass is introduced as a lubricant by placing a fiberglass "sock" over the piercing mandrel.



of free machining stainless steels which materials have not been successfully pierced by the rotary piercing method. There are many others such as several of the acid resisting alloys, tool steels and the super alloys used in gas turbines. Other materials such as molybdenum metal, vanadium, titanium and zirconium could be included in this list.

Where necessary these materials can be further processed after hot extrusion, although in most cases some modification of regular finishing practices will need to be instituted in keeping with the characteristics of the specific material. Chemical engineers and others would do well to look to this new process as a production source for new tubing materials which will help solve some process problem or assist the engineer in designing more efficient equipment for his particular application.

ECONOMIC SIGNIFICANCE

For the higher grade alloys, tubular extrusion enjoys a considerable economic advantage over rotary piercing particularly where cold reduction takes place subsequent to the production of a hot finished tube. The advantage in this case is the ability of extrusion to accomplish the following:

1. Produce a tube free from breaks in the surfaces such as may be found on a rotary pierced tube.
2. Produce smaller, lighter walled tubes than rotary piercing thereby eliminating cold passes.
3. Produce high alloy tubes at a faster rate per man hour than is possible by rotary piercing.

The extruded surfaces already produced have required almost no grinding on the outside surface, and the internal surface has been so good that no work need be done, even on requirements for redrawing. This has resulted in a reduction of better than 50 per cent in the work and material previously lost in grinding out surface defects. This is a very important gain because in some cases the conditioning can account for a substantial amount of production costs. It is expected that the surface finish will show still further improvement in the future.

The ability to produce a small light wall tube by extrusion also bypasses an appreciable amount of cold work. While leaving a sufficient number of passes to assure the surface and mechanical characteristics of a cold worked tube, the pattern of sizes is such that roughly half the cold work passes may be eliminated by producing tubing by extrusion. Thus, both the saving in passes and the reduction in conditioning time will have an impact on the in-process time, with resultant effect on delivery time under emergency conditions.

For stainless steels, production per man hour by extrusion will actually exceed that of a rotary piercer, rolling mill and reeler set-up with a rotary furnace producing a similar range of sizes. Although less pieces per hour are produced on the extrusion press, the weight per piece is far greater than that produced on a rotary piercer. It is estimated that the production per man hour by extruding is 30 per cent greater.

In high alloy business where small orders are prevalent, flexibility of production is another prime advantage offered by extrusion. To change size on the ex-

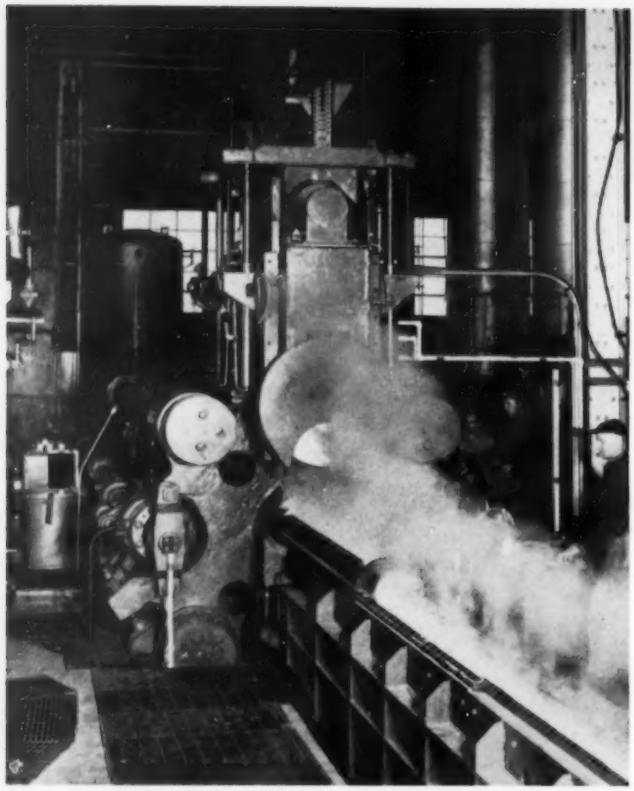


Figure 9 — The new extrusion equipment opens up new possibilities in the manufacture of tubes.

trusion press requires replacement of the mandrel and the insertion of a different size die. Less than four minutes are required to make this change.

In the case of carbon steel and low alloy steel grades, the output in pieces per hour on the rotary piercer is so high that it is doubtful whether the extrusion method could compete.

A general feature of economic importance is the ability of the extrusion process to produce special cross sectional shapes either tubular or solid. In the case of solid shapes, this means of production compared with rolling is particularly economical in terms of tool and changeover costs for small quantities. Extrusion in tubular form may be made in a variety of shapes other than circular with fins or wings of various sorts on both the interior and exterior surfaces.

SUMMARY

While the extrusion process for producing non-ferrous tubes and solid shapes is a fairly old method, it was the origination in France of the Ugine-Sejournet process, using glass as a lubricant, that has made the hot extrusion process much more practical and less costly for producing stainless steels and highly alloyed refractory metals.

The ability of this method to produce seamless tubing and solid shapes from the high alloy and high melting point metals opens an immense new field of tubing usage. Applications in processes and equipment requiring higher temperatures and pressures and where the need exists for increased resistance to corrosion are expected to create quite a demand especially in the chemical, oil refinery and power generation industries.

Plan to Attend

1952 ANNUAL AISE CONVENTION

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IRON AND STEEL EXPOSITION

CLEVELAND PUBLIC AUDITORIUM

CLEVELAND, OHIO

SEPTEMBER 30, OCTOBER 1, 2 AND 3

STEEL AND INDUSTRIAL RELATIONS GROW TOGETHER

By JAMES K. SUTHERLAND
General Manager, Steel Division
Ford Motor Co.
Dearborn, Mich.

JAMES K. SUTHERLAND

. . . . with the growth of steel into one of the largest industries, the problem of industrial relations becomes more complex . . . .

▲ WE are inclined to think of the cradle of the American iron and steel industry as located in the states of Pennsylvania and Ohio, where a great percentage of our steel producing capacity is concentrated. My enthusiasm for the potential of steel in Michigan has led me to do considerable research on the start of steel in Michigan, and it is very evident that Michigan has always played a major part in development of the iron and steel industry.

During my studies on this subject, I unearthed a dusty volume "Entered According to Act of Congress, in the Year 1891" by James M. Swank. Mr. Swank was secretary and general manager of the American Iron and Steel Association for 20 years, from 1872 to 1892. Of particular interest to me was one authoritative comment in which Swank states that J. G. Butler was one of the partners in a firm that built the first forge in 1854 or '55 on Dead River. Mr. Butler was the father of J. G. Butler, Jr., of Youngstown, Ohio, general manager of the Briar Hill Iron and Coal Co. The Briar Hill Iron and Steel Co., as it was renamed, became part of the Youngstown Sheet and Tube Co., and I served there for a number of years as a part of management, and in later years was appointed as manager of the coke ovens, blast furnaces, open hearths and mills.

If we can believe the census of 1840, there were 15 blast furnaces in Michigan in that year—one in each of the counties of Allegan, Branch, Cass, Kent, Monroe, Oakland, two in Calhoun, two in Washtenaw, and five in Wayne. Some of these furnaces were doubtless foundries, particularly in counties lying upon or near Lake Erie, over which vessels could bring pig iron for these foundries from the neighboring states. Others were undoubtedly true blast furnaces, producing household and other castings from bog ores. Their total production in 1840 was only 601 tons of cast iron.

From 1840 to 1850, the iron industry of Michigan appears to have made little progress, and possibly declined. From 1850 to 1860, a marked improvement took place. Three new furnaces were built in Kalamazoo, Quincy, and branch counties in the southern part of the state to use bog ore; and in the northern peninsula and at Detroit and Wyandotte, a start was made in smelting the rich ores which had been discovered in the now celebrated Lake Superior iron ore region.

It is a curious fact that three bog-ore furnaces were built in Michigan after 1850. The discovery of the ore range at Mesabi in the upper peninsula during the very same period was changing the course of the steel industry in the United States, and it is surprising that the mother state of highgrade iron ore should be building furnaces to use bog-ore.

I learned from A. P. Swineford's "History of the Lake Superior Iron District" that the existence of iron ore on the southern border of Lake Superior was known to white Indian traders as early as 1830. The same writer further informs us that the first discovery by white men of the iron ore of this region was made on the 16th of September, 1844, near the eastern end of Teal Lake by William A. Burt, a deputy surveyor of the federal government. In June, 1845, the Jackson Mining Co. was organized at Jackson, Mich., for the purpose of exploring the mineral districts of the southern shore of Lake Superior. Mr. P. M. Everett, the president of the company, was the leading spirit of the exploring party which secured possession of this valuable property. The actual discovery of Jackson Mountain was made by S. T. Carr and E. S. Rockwell, members of Mr. Everett's party, who were guided to the locality by an Indian chief.

Referring to the iron ore of Jackson Mountain in a letter written at Jackson, Mich., on the 10th of No-

vember, 1845, Mr. Everett says that: "Since coming home, we have had some of it smelted, and find that it produces iron and something resembling gold—some say it is gold and copper." This smelting is not further described. In 1846, A. V. Berry of the Jackson Mining Co. and others brought about 300 lb of the ore to Jackson; and, in August of that year, writes Mr. Berry, "Mr. Olds, of Cucush Prarie, who owned a forge, then undergoing repairs, in which he was making iron from bog-ore, succeeded in making a fine bar of iron from our ore in a blacksmith's fire, the first iron ever made from Lake Superior ore." Mr. Swineford says that "one end of this bar of iron Mr. Everett had drawn out into a knife-blade."

Michigan undoubtedly would have been one of the leaders in the steel industry today if personnel engaged in the industry at that time had recognized the importance of the ore discoveries. The first use of Lake Superior ore in a blast furnace occurred in Pennsylvania near the border of Ohio. The president of this Pennsylvania company was so impressed with the boundless extent and richness and facilities for obtaining Michigan ore that his company purchased the famous Jackson mine. In 1854, there were 3,000 gross tons of ore shipped from the Lake Superior mines. By 1890, this had grown to 9,012,379 gross tons. Most of this ore was shipped to Ohio, Pennsylvania and Illinois. More than two and one-half billion tons of this ore has since passed through the Soo Canal, which links Lake Superior with the lower lakes, since the canal was put into operation 96 years ago.

By 1883, most of the 16 blast furnaces built at various points in Michigan were abandoned due to the fact that they were built to use charcoal, and timber for this purpose was scarce.

Continuing my studies on this subject, I found that the first pig iron produced in the Lake Superior region was on Dead River, three miles northwest of Marquette, in 1858 by Stephen R. Gay, who leased the forge of the Collins Iron Co. and converted it in two days—at an expense of $50—into a miniature blast furnace. Today, to build a blast furnace complete with all the supplemental facilities required, would cost approximately $25,000,000.

In February, 1858, as I learned from the records of the American Iron and Steel Association, Mr. Gay wrote to C. A. Trowbridge, that his furnace was "2½ ft across the bosh, 8 ft high, 12 in. square at the top and 15 in. square in the hearth," and would hold 8 bushels of coal. Compare these sizes to our William Clay Furnace, which is 31 ft across the bosh, and 108½ ft high. He gives the following details of its first and only blast: "Began Monday, finished and fired on Wednesday; filled with coal Thursday noon, blast turned on Friday noon, and thenceforth charged regularly with one bushel coal, 20 lb of ore, and 7 lb of limestone. Cast at six o'clock 500 lb, and again at eight o'clock Saturday morning, half a ton in all, 92 lb of which were forged by Mr. Eddy into an 85-lb bloom. Again, in comparison to modern days, our William Clay furnace consumes 4,500 tons of stone, ore and coke daily. This means 150 rounds a day and produces on an average of 1,500 tons every 24 hours. Our production of iron is over one million tons per year. In 1950 we produced 1,084,458 tons and we have exceeded this figure by approximately 50,000 tons in 1951.

The little furnace previously mentioned was run two and a half days, made two and a half tons, carrying the last eight hours 30 lb of ore to a bushel of coal, equal to a ton of pig iron to 100 bushels of coal."

The first regular blast furnaces in the Lake Superior region were built by the Pioneer Iron Co. in the present city of Negaunee, convenient to the Jackson mine, with Pioneer No. 1 put in blast April, 1858 and No. 2 in May, 1859. Both furnaces were owned by the Iron Cliffs Co. They were burned and rebuilt in 1877, and operated for some 14 years afterwards.

It is an established fact that the birth of the iron and steel industry—in the west or midwest—dates from the establishment in 1855 of an iron rolling mill with two small charcoal blast furnaces at Wyandotte, Mich. The very first heat of bessemer steel ever made in America was blown in an experimental plant at the Wyandotte mill in 1865.

In 1884, there were three active rolling mills in Michigan; the Eureka, formerly the Wyandotte, at Wyandotte, built in 1855; the rolling mill of Baugh Steam Forge Co., at Detroit, built in 1877; the forge having been built in 1870; and the Detroit Steel and Spring Co., Detroit, which commenced the manufacture of crucible steel. In 1891, the same rolling mills were still in operation, and a new one, built in 1890, was in operation at Muskegon. The Detroit Steel and Spring Co. added a Robert-Bessemer steel plant to its works in 1889.

Because of present-day economics, I am sure that we all are confronted with budget problems and perhaps you will be interested in the cost and payrolls of some of the early furnaces and mills. For instance, the Eureka Iron Co., City of Detroit, was organized in 1853 with a capital stock of $500,000. That makes me stop and think about the differences in our money values then

Supervisors meet to plan industrial relations. Key personnel of Ford's Steel Division shown seated left to right are: D. L. Newkirk, Manager Blast Furnaces and Coke Ovens, James K. Sutherland, General Manager, Steel Division, W. J. Reilly, General Production Manager, Steel Division, D. P. Cromwell, Assistant Manager Blast Furnaces and Coke Ovens. Standing left to right are A. Krause, Manager Rolling Mill, C. W. Conn, Manager Electric Furnace and Open Hearth.

and now, and the differences in the capital required to provide employment over the last hundred years. During the past five years, we have spent approximately $100,000,000 to round out our operations. It would cost $350,000,000 for us to replace our present facilities. Compare this with $500,000 to build a plant in 1853.

The monthly payroll for 700 employees of the Eureka Iron Co. and all officers and executives amounted to $35,000. This represented going wages of that date paid to practically all working men. Today, steel industry employees are among the highest paid in the land. The steel industry representing 680,000 people in our country will be paid approximately 3 billion dollars for the year 1951 and exclusive of the earnings per hour we also have pensions, social security and insurance. Today, all of the industry has these extra benefits.

It is hard to say which has grown more rapidly, the necessity for better industrial relations or technical improvements. Industry has moved quite rapidly in the past twenty years, and has accomplished much in the way of increased production. Many of the open hearths in the country have been rebuilt and are now putting out twice the tonnage for which the furnaces were originally constructed and concurrently with this expansion in production working conditions have been improved and more and more safety hazards eliminated. This has been made possible only through the constant effort of management and labor. Today, the steel industry is considered the safest of all heavy industries, and average earnings in the steel industry rank among the highest.

Probably, in my interest in the start and growth of steel in Michigan, I have strayed away from my assigned subject, "The Growth of Steel and Industrial Relations at Ford."

Ford Steel Division has grown steadily. In 30 years the plant has expanded into a well-rounded unit. All of the raw materials can be brought to our docks at the blast furnaces where all stone, ore and coal are unloaded to start the basic operation of making iron and steel through our coke plant, blast furnace, open hearth, electric furnaces and rolling mill operations. Our steel then goes directly to our press shops and assembly plants where a well-trained and informed group of employees who appreciate that quality is the best assurance we have for our security convert them into automobiles, trucks and tractors.

The first coke produced in the Ford mill was made in 1919. In 1937, all batteries were replaced with two 61-oven batteries, with a third 61-oven battery being added in 1939. A fourth battery of 37 ovens is now being erected. This will give us a total coke capacity of approximately one and a half million tons annually.

The first blast furnaces—the Henry and the Benson—made iron in 1920 and '22 respectively. The William Clay went into production on November 20, 1948.

The first steel made at Ford was tapped from electric furnaces in 1923, with the first open hearth steel being tapped on June 20, 1926. With regard to the growth of steel at Ford, suffice it to say, that not too many years ago, Ford steel operations was something of a hobby or a show place for Henry Ford. Production has increased approximately 100 per cent since then. Through expansion and the teamwork of management and labor, today Ford steel ranks tenth in the nation.

We are presently expanding and modernizing our cold mill operations which will further improve working conditions and concurrently help to reduce our product costs. The improvements presently being made will materially help our material handling problems and improve our production yield through waste reduction. As a result of these changes, we will be able to process 40,000 lb coils, whereas just a matter of a few years ago we were quite proud of a 4,000 lb coil.

Much has been accomplished throughout the industry in the way of increasing iron and steel production. In 1951, the steel industry produced 78 million tons of pig iron and 108 million tons of ingots.

As the need for steel has increased, our capacity to produce steel within these United States has grown until today the United States stands out as producing more steel than all the rest of the world put together. Within this present 5-year period alone, the steelmaking capacity of the nation will have increased nearly 15 million ingot tons. You can appreciate the magnitude of such expansion more clearly when you realize that such an increase is almost equal to the total present capacity of the entire British steel industry.

But astounding as the growth and the progress that has occurred in the past seems to those of us who have grown up with it, the opportunities of the future present an even greater challenge to our imaginations. The amazing developments that science and engineering have brought, even within the past few years, have opened up great new fields for exploitation and progress in iron and steel manufacture. The use of atomic energy for fuel in the production of iron and steel, the remote control by means of television of all hot and hazardous operations at a distant location which will provide a safe and more comfortable manipulation of these functions, and the electronic weighing and recording of production even while it is being produced, are only a few of the great innovations that the future will undoubtedly bring.

The progress that I anticipate will be made within the next few years, has prompted me to recommend the setting up of a department within our organization, whose sole function can be the planning of facilities and products designed to keep us abreast of the rapidly changing times.

Within the past six months, despite the remarkable increase that has been made in steel production, automotive production has been drastically reduced. When I say drastically reduced, I mean that in 1951 our production as compared with the year 1950 was cut approximately 21 per cent and at the present time, our schedules indicate that we will produce in the first quarter of 1952 approximately 50 per cent of the cars produced in the best three months of 1950.

During the first 11 months of 1951, the Ford Motor Co. employed 135,000 people. With the drastic controls being put on by our government, we face a serious problem of unemployment. This has been brought about only because of the regulations directed by our government.

Many of you know that in the days gone by, good industrial relations did not exist throughout the steel industry. In fact, throughout industry generally, we failed to recognize the need for good human relations with our employees. Some supervisors were fair, also

good leaders; but these were among the minority. Today a supervisor must be thoroughly familiar with the policies of his company, and procedures are set up to convey down to all workers such basic information as his responsibilities with reference to safety, quality, productivity and costs. I believe we can all agree that this is where training plays an important part.

Many of you will remember, before industry grew so large, especially in those communities where the population was small, many of the supervisors knew each and every man working in the plant. Today, because of the size of our plants, this becomes a most difficult problem. However, in my opinion, a good supervisor (and I include in that classification the foreman, general foreman, and superintendents) should personally know each of his fellow workmen and be ready and willing to discuss his problems with him. This is what we call "Human Relations" in the Ford Motor Co.

Mr. Henry Ford II, in a talk given by him sometime ago, made this statement, "No business will run itself. No methods or formulas can be devised to substitute for human judgment and leadership."

How much easier it is to improve production when all who are engaged in that joint effort are familiar with the problem. I think the average American still has enough pride in being an American, to do a good day's work if his responsibilities are thoroughly explained to him. In many cases, it has been proven that supervisors were not familiar with the economics of their problem and as a consequence could not instruct their employees in matters which would allow maximum efficiency and make possible a more successful operation. In my opinion, such a man has not been properly trained.

Just a few short years ago, when I first came to Ford Motor Co., Industrial Relations for the whole Rouge area (comprising some 80,000 employees), was handled by one central industrial relation department. Salary and hourly personnel matters, workmens' compensation, safety and training were all part of this central industrial relations activity. Sound industrial relations policies had already been established, but the bigness of the Rouge prohibited Mr. Henry Ford II's policies on human relations from getting down, as they should, to all employees. Mr. Ford, being a firm believer in the fact that, if a contented and happy working force could be attained, production would be improved and this in turn would create more sales, decided that not only for business reasons but for good human relations it was necessary to decentralize activities.

The Steel Division, or as it was known at that time, "Steel Operations" was the first decentralization to take place in October 1949. Needless to say, I felt quite honored and happy to have a part in the first decentralization for the promotion of better human relations. At this time I was fortunate in being able to secure the services of Otis U. Walker as my manager of industrial relations. Otis assisted us in decentralizing steel operations from the rest of the Rouge plant, and set up an organization to handle all of our industrial relations problems, feeling that when we had our industrial relations operations set up then we could go forward with the other necessary departments that also had to be instituted, an engineering department, controller's office, and others. During the past three years, our industrial relations department has grown from one individual to the present 55 employees.

I want to repeat again, that because Mr. Henry Ford II believed human relations was our most important problem, our first attempt in setting up a completely decentralized operation was to start our industrial relations program. When I look at the industrial relations department's payroll and cost, in light of present day budgets, I often like to rib Otis a little to the effect that he has gone overboard to promote industrial relations in the steel division. But seriously, if it takes three times as many employees as we now have, it is my intention, backed by Ford policy to promote the best human relations within any industry in the country and this, I personally feel, can only be established through sound training.

Our industrial relations department today consists of salaried and hourly personnel sections, labor relations, employee services, and training sections.

Let us look briefly at each section—salaried personnel handles management relations with salaried employees, studies and checks salaried job classifications and rates of pay, secures personnel for salaried positions, and administers general company policies on a divisional level.

Hourly personnel section performs similar functions for the hourly employees.

Labor relations provides our employees with a means of getting the facts when there is any question of doubt as to responsibilities. Before any discipline is applied, all problems are thoroughly analyzed by operating management and labor relations to assure good human relations which, in my opinion, means fair treatment.

Employee services section consists of services to all employees—such as safety, workmens' compensation, suggestion and management proposals, recreation, retirement and pensions and anniversary awards.

Our training section conducts classes each week with all levels of supervision on such subjects as safety, and quality and personnel policies and cost. They are responsible for management development training.

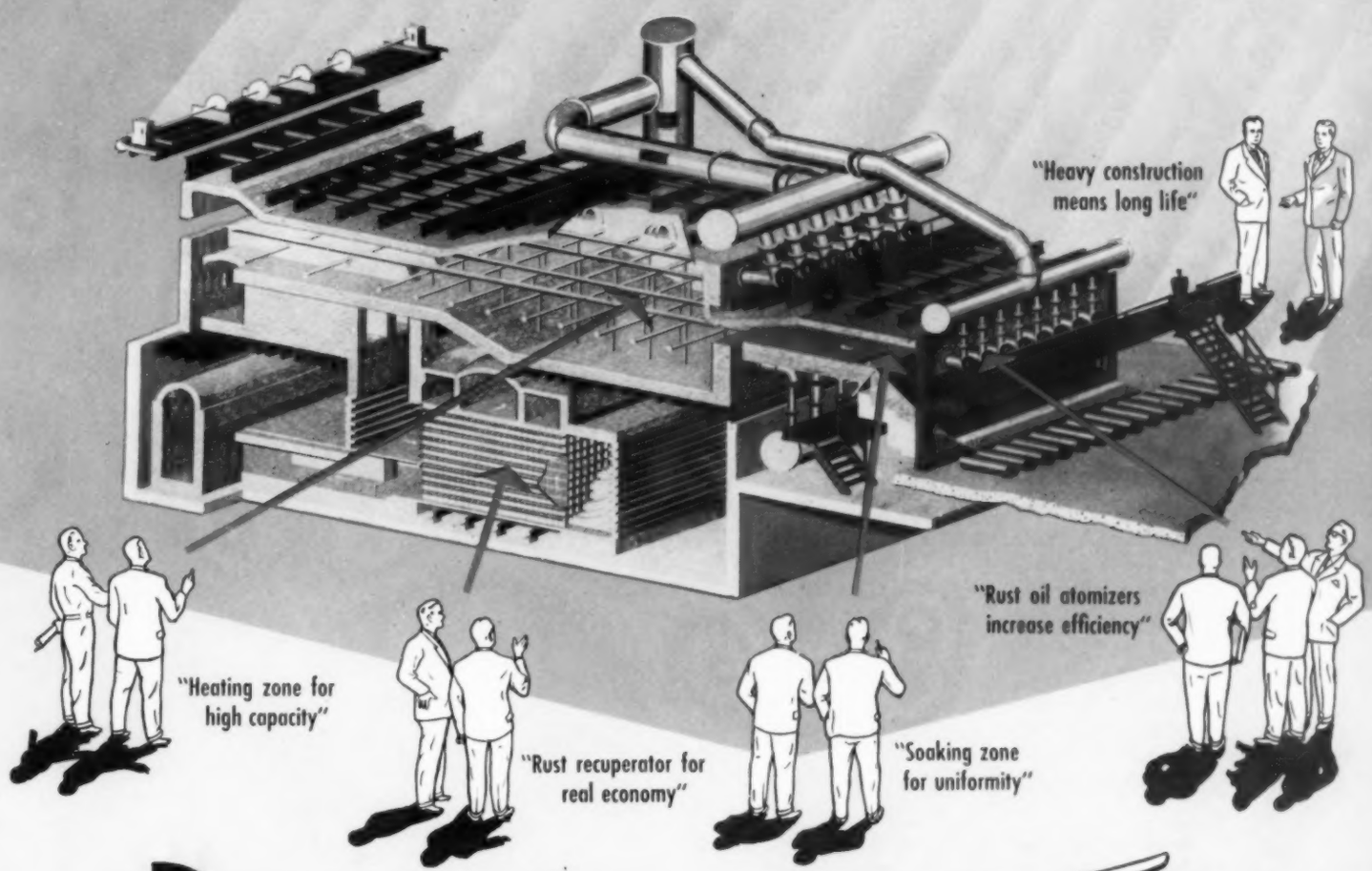
For my part, the good job that has been and is being done has already more than paid off.

At our recent management dinners for all supervision in steel division, the job that has been done by industrial relations was exemplified by six members of supervision who stood up and were applauded for their combined total of 240 years of service with Ford. Their pride in being with Ford for that time and particularly with the steel division, did not stem solely from rates of pay or such monetary values.

With all of the push that has been necessary in the past few years to get out steel production, had we not had a good understanding of industrial relations policies and procedure, we would have been far short of accomplishing our goal. Our industrial relations people have done an unusually good job of assisting our supervision and providing them with information necessary to do a good job and have a contented attitude.

When the day arrives that we, as supervisors or members of management, fully understand all of the problems of our employees, we will not only have better production but a better world in which to live.

FURNACE MEN KNOW THEY'RE BETTER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ORE BRIDGE SPAN USES ARC WELDING FOR THE FIRST TIME

By H. E. CABLE
Welding Engineer

▲ PREFABRICATION by shop welding of 28 cross frame sections in the span of a new 12-ton ore and coal handling bridge for Dominion Foundries and Steel Co., Ltd., Hamilton, Ontario, marks a further step forward in the utilization of welding in the design and construction of this type of structure. While pier and shear legs, trucks and man-trolleys for ore bridges have been recognized as readily adaptable to welded fabrication, there has been no application of welding to any of the load carrying members of the span structure.

However, welding offers many advantages in terms of cost, reliability, weight reduction, ease of maintenance and design simplification, so Heyl and Patterson, Inc., Pittsburgh designers, fabricators and erectors of the Hamilton bridge, determined to design the shop assembled members of the span for welding. The result was a span approximately 50 per cent welded. Assistance in the design was given by Lincoln Electric's Pittsburgh weldesign engineers.

Shop fabricated cross frames, made in halves, were shipped to the site of the bridge and field erected by riveting. Welded joints were specially prepared for butt or groove welding with full penetration wherever high stress conditions were encountered. Design stress in welds was limited to 13,000 psi, and at certain critical connections was cut back further to 10,000 psi.

A few basic dimensions will give an idea of the overall size of the structure. Pier and shear legs are each 95 ft high and are set 300 ft apart. They travel on 12 four-wheel truck units of standard railroad gage, three trucks to each corner of the bridge, with the load being distributed through all welded main and intermediate equalizers, made of 30-in. and 21-in. I-beams, respectively. Each 12-wheel truck weighs 62,000 lb. They are worm driven by 19-hp motors mounted on each 4-wheel truck unit giving a bridge traverse speed of 90 fpm. Wheels are the single-flange type, 30-in. diam.

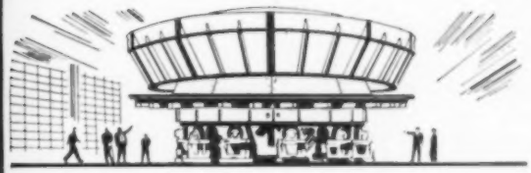
The bridge span is mounted on a pivot point at the shear leg to accommodate skewing to a maximum of 4 degrees either way from square. This

Figure 1 — Most of the cross frames in the span of this 12-ton ore and coal handling bridge were shop welded, shipped to the site and field erected by riveting. The span is considered to be 50 per cent welded.

Figure 2 — Rail stringers carrying the man-trolley, shown in this view looking across the inside of the span, are 30-in., I-beams and are connected to cross frames and bracing to distribute pulsating loads uniformly.

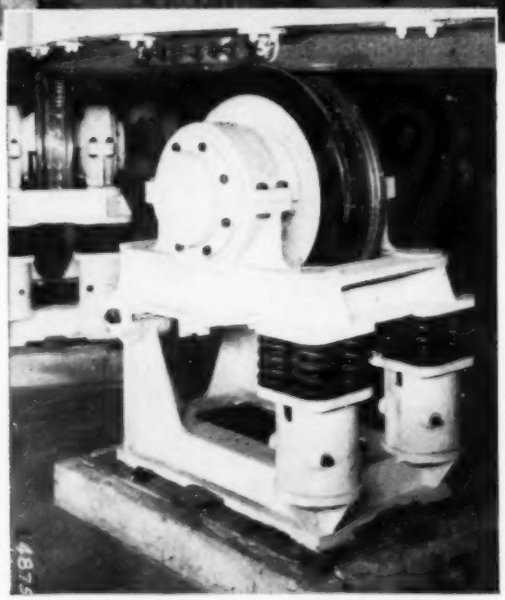
HYATTS PREFERRED

For New Equipment or Changeovers



This Rotary Cooler licensed under U. S. Ser. Nos. 519322 and 613368 is a recent development of the Arthur G. McKee Company and was built by The William B. Pollock Company for one of the leading steel mills.

As a result of the successful performance of this original unit, other mills have since installed similar Hyatt-equipped coolers on their sintering plant operations.



This mammoth cooling mechanism, heavily loaded, turns easily on a battery of husky Hyatt-equipped track wheels as shown above.

Wherever wheels, gears and shafts turn in steel mills you will find Hyatts carrying heavy loads, eliminating bearing wear and care and helping equipment operate easier and last longer.

Whatever the application—rotary coolers as illustrated—or tables, cars, cranes, mill motors or other auxiliary equipment, there are Hyatt Roller Bearings in sizes and types to suit most every requirement.

Having served in steel mills so well for so many years, Hyatts are far out in front today as the preferred bearings for new equipment or changeovers. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

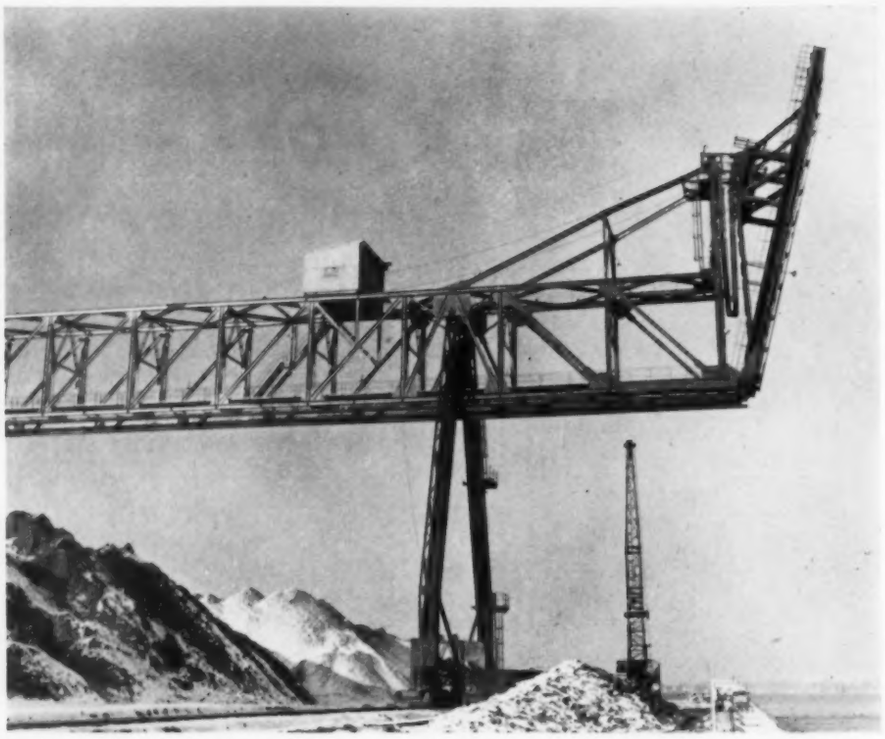


Figure 3 — Hinged apron 91 ft in length, extends out over the water. Spring buffers are positioned at its end to arrest the trolley should limit switches fail in an emergency.

is a ratio of 1 in 15 or a maximum travel of 20 ft by either leg from the square position. Top of the shear leg leans outward 3 in. when the bridge is square and leans inward 5 in. at maximum skew. Limit switches prevent the shear leg from traveling beyond the extreme skew position.

Two pairs of rail clamps are mounted on each of the welded steel pier and shear leg sills. By means of heavy tapered counterweights, they exert clamping action on the rails of 120,000 lb per pair, or sufficient to hold the bridge firm in a wind of the unlikely velocity of 117 mph. The sill elements are 42 ft long to the points where they connect with the bridge legs, while the legs themselves are 75 ft from center to center of the trucks.

The bridge span features a welded hinged boom or apron extending out over the edge of the dock about 87 ft in the lowered position. This means that the trolley and bucket can run out nearly 135 ft beyond the centerline of the shear leg, the travel being arrested by both limit switches and a spring buffer at both ends of the bridge track.

The all-welded trolley itself is of the turntable type, permitting the bucket to be power rotated at about 2 to 5 rpm in the hold of a ship so that the ore or coal may be more expeditiously removed. With full load, the trolley assembly weighs 200,000 lb. Two 150-hp variable voltage drive motors drive it at a traverse speed of 900 fpm. The bucket hoist is of the two-drum type with two 150-hp motors. One motor drives the close drum and one motor drives the hold drum. The hoist motors are mounted in a unique "stacked-up" position (Iron and Steel Engineer, October, 1950) to eliminate excess weight in both trolley and bridge span structures.

The bridge trusses comprise 16 panels, framed by 17 cross frames, fourteen of which are shop welded manually in specially designed fixtures to ensure correct shape. Welding was done with mold steel shielded-arc electrodes. The cross frames are connected by multiple panel riveted top and bottom 14-in. wide flange I-beam chords. Rail stringers are 30 in. I-beams field riveted to the lower ends of the shop fabricated cross frame members which provide supports for them.

Trolley rails carried by the stringers are 104 lb with thermit welded joints. In the hold of a loaded vessel, the trolley bucket may be lowered 19 ft, 6-in. below normal water level.

Power is supplied to the trolley through twelve conductors supported from the bottom chords and rail stringers. By using variable voltage control on motors, the weight and bulk of rheostats are not carried on the trolley. Power is supplied to the conductors from a motor-generator set mounted atop the span at the pier leg.

Figure 4 — Hoist drive motors are "stacked-up" to conserve space and to facilitate design of turntable which allows bucket to be turned in the hold of a ship for complete removal of ore or coal.

a $434. investment returns $16,150.

and more to come

Unretouched photo shows TSP gears with hardly any wear after 285 days of service.

INDUSTRY REPORTS

Gearing for seamless tube mill kickout drive. Tube and bar mill outlet transfer table at large manufacturer of pipes and tubes.

SERVICE RECORD

TSP GEARS	COMPETITIVE GEARS
285 days continuous service and still in operation	10 to 15 days maximum service
No noticeable wear on TSP gears.	Taken out of service due to wear

large pipe and tube company report TSP* parts outlast them al

This set of "Tool Steel Process" Gears cost this company on $434.00. Actual customer service records proved that TSP gears alreac have shown a 21 to 1 superiority in tonnage service life over competiti gears. Total savings in material, man hours, and downtime, so far, amou to $16,150.00. As these gears are still in service, the savings continue mount. A further proof of TSP superiority is the fact that during this perio operations of the mill were increased and tonnage was produced at higher rate.

Next time you need replacement parts—specify "Tool Steel Pro ess" parts. Write for descriptive bulletins.

* TOOL STEEL PROCESS PRODUCTS

. . . the products that carry an absolutely positive GUARANTEE to give a longer life in the same service than any other product.

THE TOOL STEEL GEAR AND PINION CO.

CINCINNATI 16, OHIO, U. S. A.

THE STANDARD OF QUALITY SINCE 1909 FOR GEARS • PINIONS • ROLLS • WHEELS AND OTHER HARDENED PRODUC

In designing the cross frames for welding, recognition had to be given to the important difference between pulsating and static loads. The former may range from 10 to 100 per cent of total loading in cycles a year. Alternating stresses of this kind ruled out lap joints and fillet welding at most shop connections in the frame members, since concentration of stress in any particular part of a section seriously affects fatigue strength even though it may have little or no effect on the ability of a joint to carry a steady load.

If the edge portion of a welded connection fails, the crack progresses into the remaining material, causing it to fail. The fatigue crack always starts at the point of highest concentration of stress, its presence causing a redistribution for the worst of the stresses adjacent to the crack, followed by a rapid progressive failure of the connection. Thus, in welded construction, the gross area in a weld means little if pulsating loads are involved. Hence, a limiting value of unit stress based on the gross area of the joint, is of little value.

B. A. Rose, Heyl and Patterson's vice president in charge of engineering, thinks that in view of the distortion which exists in the stress pattern in conventional types of structural steel connections, it is well to use such standard limits for only those static loads where the pulsation on a cycle basis exceeds no more than 20 per cent of the total value. For the remaining cases where vital connections are involved and where pulsations in load greater than 20 per cent are encountered, he favors elimination from consideration of that portion of the weld isolated from the direct path of the forces through the connection and limitation of the stress in the remaining weld area to about three-quarters of standard values.

Forces passing through fillet welds in tension where no weld preparation is made have to pass around the rough edge of the gap left inside the weld. For this reason, welds carrying heavy pulsating loads need full preparation with either single or double vees. Where possible these welds should be made from both sides to assure full penetration. Accompanying sketches show typical welding details developed for the top and bottom sections of the bridge cross frames.

Mr. Rose further points out that design practice with riveted construction neglects the pattern of forces passing through a connection calling merely for enough rivets and steel to obtain stresses below those allowable for such construction. That it has been satisfactory under pulsating load is attributable largely to the fact that those rivets in a vulnerable spot in the connection can yield and even fail, if need be, and remain isolated so that the entire joint is not necessarily involved.

Each welded joint must be studied from the above viewpoints and its components arranged so that the forces are kept spread as nearly as possible over the section of the joint. A uniform stress pattern is generally impossible of complete accomplishment, but by judicious planning, the peak concentrations can be held to reasonable values. This type of planning must be applied to all welded joints in structures where pulsating loads are carried, if complete satisfaction with welded construction is to be obtained in such cases. Furthermore, if design of the joint is properly done, the welded structure is capable of carrying much greater pulsating loads pound for pound than a comparable riveted structure can carry.

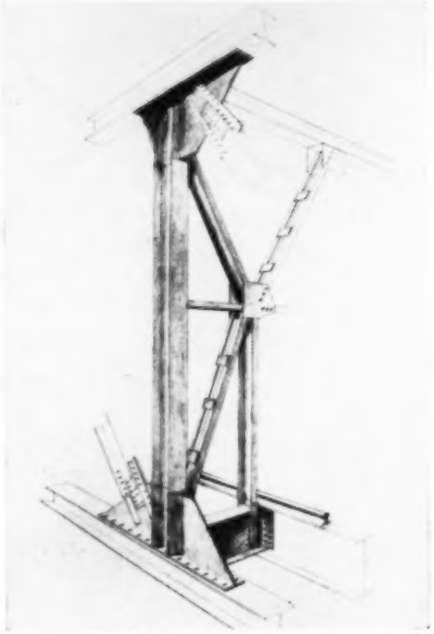


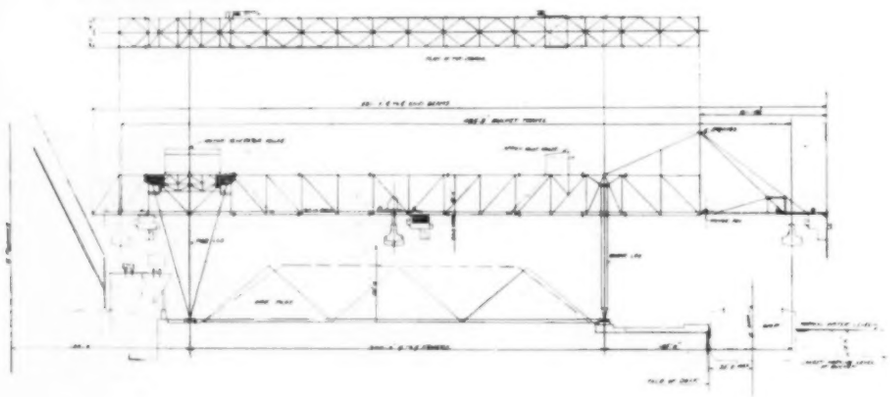
Figure 6 — Note elimination of detail in shop welded, field riveted cross-frame.

The Hamilton bridge is the first of two to be erected there and is now in full operation. Cleanliness of the design prevents the usual accumulation of dust and corrosion around complicated riveted connections and also contributes to reduced cost of maintenance painting.

Use of wide-flange beams for top and bottom chords, top cross members, and some diagonal bracing eliminated the need for complicated built-up structural sections that are difficult to clean and paint in the field. All riveted joints for main stress carrying members were subpunched or subdrilled in shop and reamed during assembly.

There are about 250 ore and coal handling bridges now in service in the United States and Canada. Their normal life span is estimated to be somewhere between 30 and 50 years. Probably half of them are nearing time for replacement or extensive repairs. Cost of a new bridge runs close to $1,000,000. Based on the experience gained with operation of the Hamilton bridge, a substantial market is envisaged for structures of the proper welded design, perhaps going even further in the application of welding than we do in the Canadian units.

Figure 5 — Schematic drawing of 531-ft ore bridge shows arrangement of structural members in the welded steel span. Bucket capacity is 12 tons of coal or iron ore.



TROLLEY FOR THE WORLD'S BIGGEST CRANE BY Alliance

Paul Bunyan used to brag about threading a needle with his enormous hands . . . but he has little on Alliance trolleys. Swiftly, but with the accuracy and control of a micrometer, the world's largest crane moves tons of molten steel with utmost safety.

The trolley is equipped with 16 double-flange track wheels which operate on rails at 30" centers. These wheels are compensated for longitudinal and transverse equalization which assures equal loading of all wheels. The rails being located over the web plates prevent flexing and cracking of top cover plate and reduces the number of diaphragms required.

This ladle crane trolley is equipped with a two-motor, synchronized worm drive, interlocked double-drum type main hoist. The synchronizing shaft employed in this scheme of gearing not only eliminates the undesirable ratchet gears but makes possible an additional safety feature in case one of the hoist motors fail. Under this condition both worms are driven by the remaining motor and all gearing functions as with two motors. In case of failure of one hoist motor on the conventional drive without the synchronizing shaft, hoisting is accomplished by only one set of gears. This imposes a double load on active gearing, the second drum being driven through the interlocking drum gears. The hoist gearing is so proportioned on all ladle cranes that the full capacity of the crane can be lifted by one motor without exceeding the quarter-hour rating.

The drum gears and pinions of the main hoist of this new crane have precision-cut, single-helical teeth, and in cooperation with the worm drive, assure vibrationless operation on either high or low speed hoisting and lowering.

All gears are fully enclosed and operate in a bath of oil, assuring long life and low maintenance.

This trolley is designed for maximum accessibility and ease of maintenance. Anti-friction bearings throughout.

The 4-part safety rope system installed on this crane affords the highest degree of safety in rope reeving.

Contact Alliance today. At your convenience a qualified engineer will discuss your heavy material handling problems. It's to your advantage.

LADLE CRANES · GANTRY CRANES · FORGING MANIPULATORS · SOAKING PIT CRANES · STRIPPER CRANES · SLAB AND BILLET CHARGING MACHINES · OPEN HEARTH CHARGING MACHINES · SPECIAL MILL MACHINERY · STRUCTURAL FABRICATION

THE Alliance MACHINE COMPANY

World's largest builders of world's largest cranes

MAIN OFFICE
ALLIANCE, OHIO
PITTSBURGH OFFICE
1622 OLIVER BUILDING · PITTSBURGH, PA.

FACILITIES STREAMLINED IN NEW RELIANCE PLANT

▲ Built last year at a cost of approximately $1,800,000 and now approaching its sixth month of full-scale operation, the new Euclid (Ohio) plant of The Reliance Electric & Engineering Co. is a multi-function structure.

It not only supplies modern facilities with simplified layout for work programming and smooth-flowing production of electronic-type packaged adjustable-speed drives and related controls, but also provides for the efficient manufacture of factory-quality renewal parts, and the speedy performance of repair service and associated customer-service activities.

Housed here, too, are research and development laboratories where new Reliance products are conceived and present ones improved, and facilities for the design, development, and manufacture of the specialized tools required by the company's plants in Cleveland and Ashtabula, Ohio.

While the new plant has been designed to serve these essential functions in the manufacture of both standard and special-purpose electric motors and engineered motor drives, it is from the engineering standpoint, particularly, that the new Reliance facility is especially noteworthy.

In centralizing its technical services and activities under a single roof, the company has gone several steps beyond the mere accommodating of 200 engineers, draftsmen, and technicians during their working hours. Into the planning and designing of these particular facilities have gone a number of important basic considerations.

In planning its engineering activities at Euclid and in designing facilities for them, Reliance has devoted considerable attention to installing the most up-to-date methods of doing engineering work and to devising ways and means of "up-grading" all such procedures wherever practicable.

Every engineer and draftsman has received individual attention in the matter of working quarters. As his "home on the job," this employee's work area has been designed for personal efficiency, conditioned for comfort and arranged to provide the greatest possible freedom from distraction. Nor has a high degree of flexibility to permit future rearrangement of facilities been overlooked.

RESEARCH FACILITIES

Considerable new equipment to facilitate research and testing has been installed, including a 250-hp dynamometer backed up by a 450-hp synchronous motor-generator set with a 300-kw d-c generator and a 312-kva alternator. Through a plug board, this unit can be connected to give its full power output at voltages of 220, 440, 660 or 1320 on 60 cycles. With the d-c generator serving as a driving motor any frequency up to 60 cycles can be obtained. Line capacity of 1000-kva at 440 volts is available for a 60-cycle a-c motor testing.

Maximum flexibility keynotes the distribution and control board. Any voltage or frequency produced in the power room can be delivered to or controlled from any location in the laboratory by means of simple patch-cord changes. Provision also has been made for distribution of power from these facilities to special tests in either the Repair Department or V*S Test and Inspection areas.

The laboratory also contains a special "sound-conditioned" room. Insulation testing ovens, instruments, recorders and other equipment are grouped in one section, where new materials and application methods are continually undergoing intensive development and improvement. In another section of the laboratory devoted exclusively to control development work, are regulator, precision speed matching devices, current con-

Figure 1 — Plant, built in nine months, has no windows that open, either in factory or office areas.

Lee Wilson

ANNEALING FURNACE DATA SHEET

NUMBER FIVE

BASIC ADVANTAGES OF LEE WILSON SINGLE-STACK PORTABLE BASE FURNACES:

1. BETTER QUALITY
2. HIGHER PRODUCTION
3. LOWER FUEL COSTS
4. LOWER FIRST COST
5. LOWER MAINTENANCE
6. LOW HANDLING COSTS

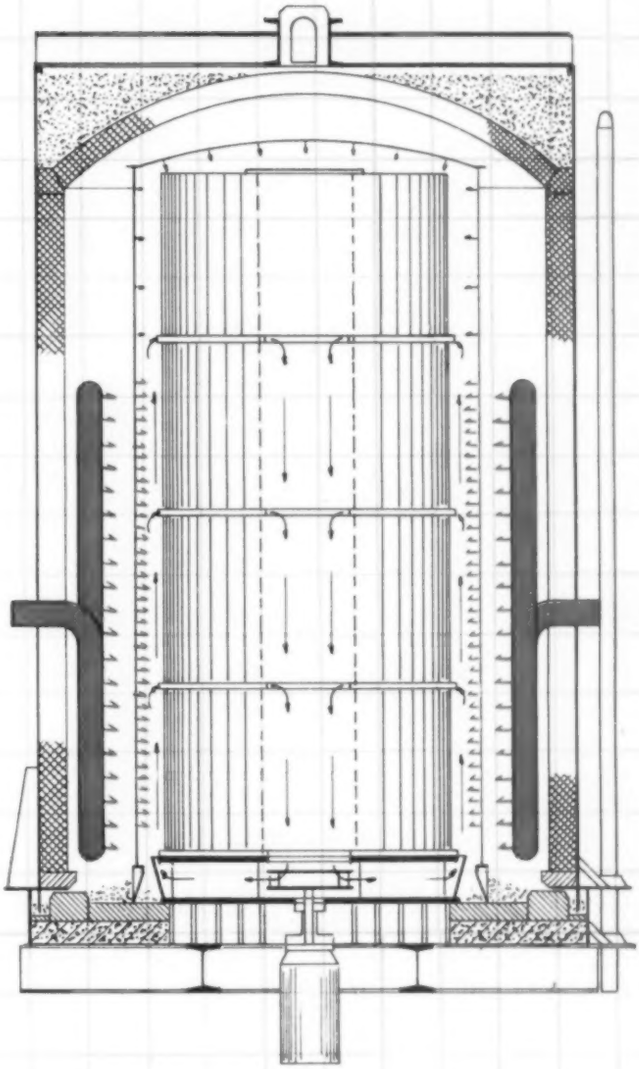
SINGLE-STACK PORTABLE BASE FURNACES SLASH MAINTENANCE COSTS

The new Lee Wilson Single-Stack Portable Base Annealing System reduces annealing furnace maintenance beyond comparison. By adopting completely portable units . . . bases, inner covers and furnaces . . . the section requiring maintenance can be taken to a repair shop where tools, handling equipment, etc., make the repair job easier and quicker. Maintenance men are not forced to work in cramped basements.

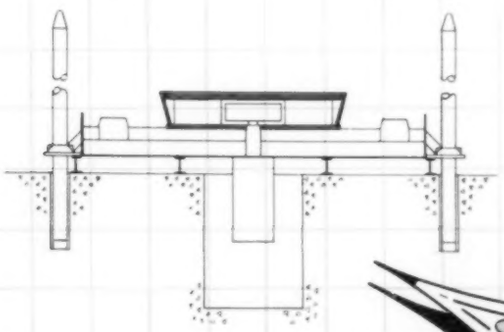
The Lee Wilson system includes an extra single-stack furnace and an extra portable base. Thus when a furnace or base requires maintenance it is simply removed to the maintenance department and the spare furnace or base quickly substituted and production continues unhampered. There's never a lost moment in annealing production.

Because Lee Wilson's system is based on single-stack furnaces the handling of the parts — or sections — to and from maintenance, requires only light cranes and handling equipment — an additional saving in building structure and handling machinery.

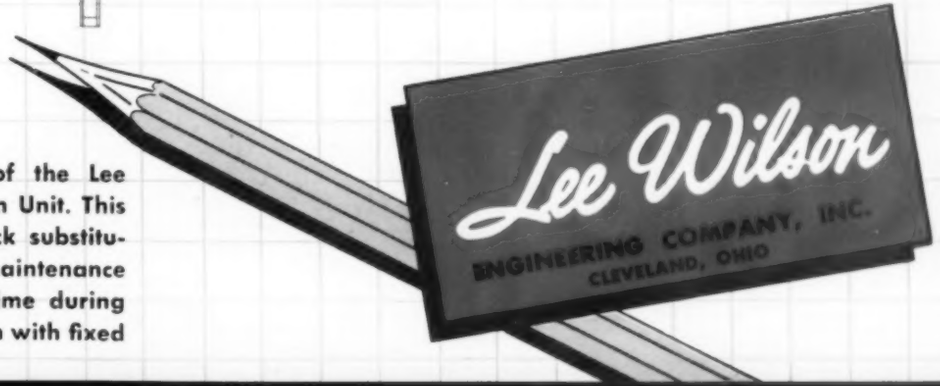
So, if you want higher annealing production and lower maintenance costs, talk with a Wilson engineer about the amazing new Lee Wilson Portable Base Single-Stack System.



The Lee Wilson Portable Base Single-Stack System of Annealing permits most efficient maintenance of equipment because any or all of the furnace, inner cover or base and fan unit is completely portable and can be easily transported to a maintenance shop for quick repair.



A cross-sectional drawing of the Lee Wilson Portable Base and Fan Unit. This easy portability permits quick substitution of a second unit when maintenance is required. Furnace down time during maintenance periods, common with fixed bases, is eliminated.



version, and other electronic controls. Breadboards are the general rule, but first samples which serve as guides for final specification and manufacturing are also made here.

MANUFACTURING FACILITIES

Design-wise, the new plant is distinctive in many respects. Planned for multi-functional usage, its production facilities are readily convertible to meet the changing requirements which may be brought about by new product developments. Layout is likewise flexible to meet anticipated needs of future expansion.

Materials handling has come in for particular attention with the liberal use of roller conveyor sections, a prime consideration in moving one of the company's chief products — V*S drives — from first assembly operations to final crating and delivery to the shipping dock. This progression is made possible by means of roller conveyor sections mounted on transfer cars for movement between conveyor lines and by roller conveyor sections mounted on electrically operated elevators for transfer between conveyors at different levels. Another indication of the attention paid to materials handling is to be found in the overhead crane system. Other materials handling and in-plant transportation operations are made easier through the use of jib cranes, skid racks, and battery-powered lift trucks.

Liberal application of color in coordinated schemes in the finishing of production and office areas was made with a four-fold purpose: (1) to lessen eyestrain, (2) to increase safety, (3) to create a more cheerful and comfortable working environment for employees, and (4) to help assure an attractive plant interior.

A combination automatic and forced air system is used for heating and ventilating. It keeps pressure inside the plant slightly above that of the atmosphere outside. The conventional boiler room or central heating plant is absent. In its place are two modern gas-fired steam boilers. Factory areas are heated and ventilated by 11 direct-fired, horizontal-type unit heaters ranging in output from 500,000 to 1,250,000 Btu.

Spotted at strategic points throughout work areas in the plant are small, completely sound-proofed shop offices. Developed by Reliance, these offices have panelized prefabricated construction, which permits easy dismantling and relocation elsewhere in the plant should layout changes dictate.

All essential plant services — air, gas, oil, water, steam, electricity — are carried overhead between roof trusses. Only exceptions are test stand circuits in the laboratory and test line from the generator room to a variable voltage (V*S) test stand in the manufacturing area proper. These utility service facilities, together with plant sewers, were installed before the concrete floor was poured.

REPLACEMENT FACILITIES

Modern industry's quickening production pace — stressing speed, speed, and more speed — in turn has put "the heat" on maintenance crews in many a plant to avoid machine outages and when they do occur to restore equipment to service with a minimum of delay.

If equipment downtime and its ensuing production loss are to be effectively limited, replacement parts required for the unit "in distress" must (1) be available from stock in the user's plant, or (2) obtainable without undue delay from the manufacturer.

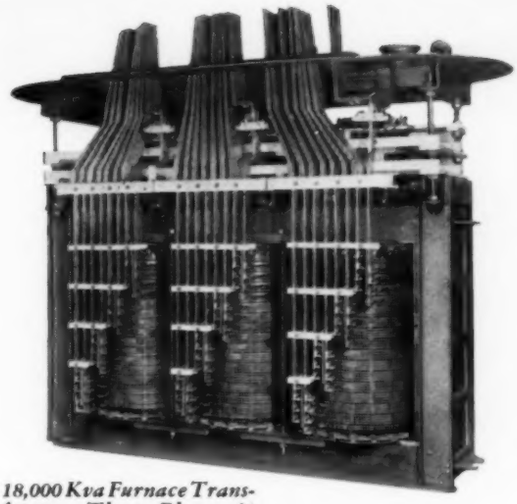
That's the basic premise upon which the motor replacement operations and activities of Reliance are founded. Functions and facilities of the company's Renewal Parts and Service Division reflect steady, continuing growth. Today, renewal parts orders account for approximately 7 per cent of the company's annual sales volume. Those who rely on this "Rush from Reliance" department to supply virtually off-the-shelf, packaged parts service find that the speedy deliveries of vitally needed electrical components not only save manhours in putting machines back into production, but also contribute to more dependable operating performance and longer productive life of the electrical equipment.

Comprising three departments — Renewal Parts, Repair, and Service — this division of Reliance occupies 35,000 sq ft of space — nearly 27 per cent of the new plant. Some 100 experienced employees are required just to handle the work performed by the three departments.

The Repair Department, as its name implies, is responsible for restoring to first-class condition, quickly and economically, Reliance-built motors or controls returned to the company for overhaul. To handle this work the department has, in addition to other equipment, a 24-in. engine lathe with 12-ft bed, two smaller engine lathes, a 100-ton forcing press, and a metallizing machine. An important new addition is a complete yet compact coil-winding section.

On-the-spot trouble shooting, special start-up, installation of equipment, and allied service jobs are handled by the Service Department. Reliance service engineers are held re-

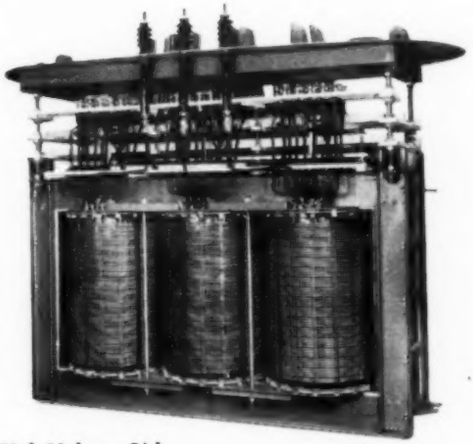
Figure 2 — In the new Euclid plant, every engineer and draftsman has received individual attention in the matter of working quarters. This has been achieved in part through the use of cabinet-height plywood partitions which not only divide the engineering room into cubicles, but also provide bookshelves and desk tops at different levels.



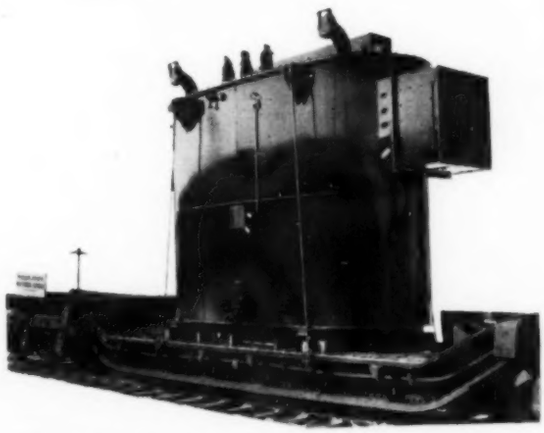
18,000 Kva Furnace Transformer, Three Phase, 60 Cycles, 55°C. Rise, Low Voltage Side

★ The transformer that supplies power to an electric furnace is an extremely complicated unit. The rules governing designs and construction of Power Transformers do not apply to Furnace Transformers. Many special conditions such as overloads, short circuit stresses, distribution of currents and reduction of eddy losses must be met by engineering skill and highly perfected workmanship.

Furnace Transformer FACTS



High Voltage Side



Completed Transformer ready for shipment

1 Overloads & Short Circuit Stresses

Electric Furnace operation inherently subjects Furnace Transformers to frequent short circuits and heavy overloads. The effect of this on the transformer is complicated by the wide range of voltages which necessitates cutting out large portions of the primary windings. The effects of both the radial and axial short circuit forces are greatly reduced in Pennsylvania Furnace Transformers by the use of Circular Coils and an ingenious winding arrangement.

2 Balancing of Stresses

Pennsylvania coils are balanced to reduce the radial and axial short circuit stresses to a minimum. **1.** The circular shape protects the coils against deformation due to radial short circuit forces. **2.** The total axial short circuit force is calculated for each design and the coils are subjected to an equivalent pressure in an hydraulic press. The ability of the coils to maintain their shape, under the prescribed pressure, guarantees that the transformer will safely withstand short circuits.

3 Distribution of Currents

Due to the heavy secondary currents, the winding must be subdivided into numerous parallel sections. A unique arrangement of the windings insures that each section carries an equal share of the current.

Careful transposition of the individual conductors of each section in the windings reduces the copper eddy losses to a minimum. This results in improved efficiency, more uniform copper temperature and prevention of hot spots.

Pennsylvania TRANSFORMERS

Furnace Transformer Experts

Pennsylvania TRANSFORMER COMPANY

CANONSBURG, PENNSYLVANIA

Greater Pittsburgh District

sponsible for quality performance and report the findings and observations of their in-plant equipment engineering work directly to the company's Engineering and Production departments.

Because replacement parts requirements of customers generally are of an extremely urgent nature, Reliance has constantly sought ways and means of improving its order-handling procedures to eliminate or reduce delays so far as possible. Part of the basic standard operating practice in this connection, for example, is the maintenance of an adequate supply stock of those items having a high usage factor, such as coils, control parts, tubes, brushes, etc.

In the company's new Euclid Plant, special racks — each 10-ft high, 4-ft wide and 60-ft long — have been installed for storing large-size parts — armatures, rotors, brackets, and the like. Smaller items, such as brushes, bearings, control parts, and hardware, are stored in special bins. Large items are crated or boxed, small ones packaged in bags or cartons. This stock of parts, packaged and ready for shipment, gives customers a time-saving supermarket-style, off-the-shelf service on between 2500 and 3000 standard replacement parts for a-c and d-c motors of from ½ to 1000 hp. Orderly, convenient arrangement of storage racks and bins enables stock clerks to select individual items with the greatest of ease and speed.

Figure 3 — Plant transportation has been kept flexible through use of a variety of battery-operated trucks specially designed for handling storage of even sizable objects at considerable heights.

Meet today's increased tonnage demands with

Custom Engineered

FURNACES by Grant Watson

Battery of six ingot heating furnaces. One of many individually engineered installations designed, built and installed complete by Grant Watson. Each furnace capable of holding six steel ingots 24-in. square by 81-in. long.

Designers of individually engineered heating and heat treating furnaces, both gas and oil fired, for reheating slabs, billets, rods, bars and blooms; forging; soaking pits; annealing and normalizing; stress relief; and other industrial heating applications.

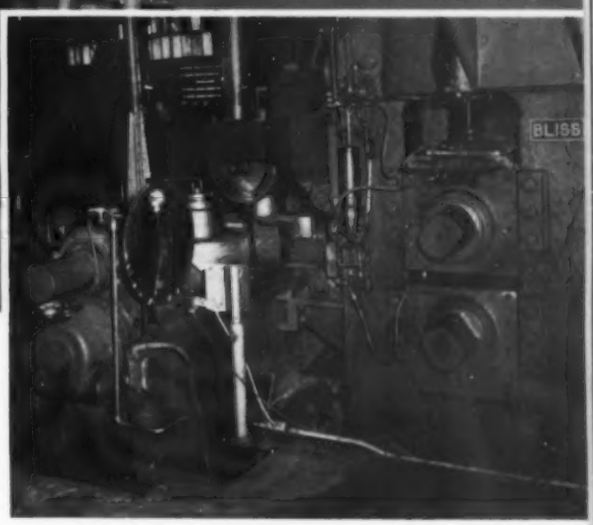
Grant Watson "Custom Engineered" furnaces deliver maximum heating efficiency, uniform product quality, positive temperature control plus the versatility and flexibility that pays off in increased tonnage and economical operation. Regular COST-FREE SERVICE after installation reduces maintenance costs, assures trouble-free performance day-in and day-out.

Write, wire or call for instant service on custom engineered furnaces to meet your requirements and specifications

GRANT WATSON CONSTRUCTION COMPANY • 1398 So. Santa Fe Drive, Denver, Colorado

Ohio Knife trims rolling time 50% with New BLISS Hot Mill and Edger

Laminated metal, with soft inside core surrounded by hard alloy steels, is hot rolled in this Bliss 19" x 24" Two-High Reversible Mill powered by an AC motor.



Combination of mill, edger and run-out table reduces material-handling manhours by 80%

Proof that the right combination of equipment and methods can contribute startling performance exists at the Ohio Knife Company of Cincinnati. Here, a new Bliss Two-High Mill and Edger hot roll 5" square stock in six passes to 3⅞", holding tolerances within ±0.005". Aside from mill accuracy on daily production runs of as long as 20 hours, Ohio Knife Company officials report that rolling time has been reduced 50%; and material-handling time, 80%.

Recommending designs and methods for efficient metal rolling has been the job of Bliss Rolling Mill Engineers for nearly fifty years. Examples of advanced Bliss mill engineering can be found in many steel, brass, aluminum and specialty plants. Consult Bliss on your next rolling mill equipment problem. And write for our 52-page brochure: "Bliss Mills and Accessories."

E. W. Bliss Company, General Office: Canton, Ohio
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E. W. Bliss (England) Ltd., Derby, England
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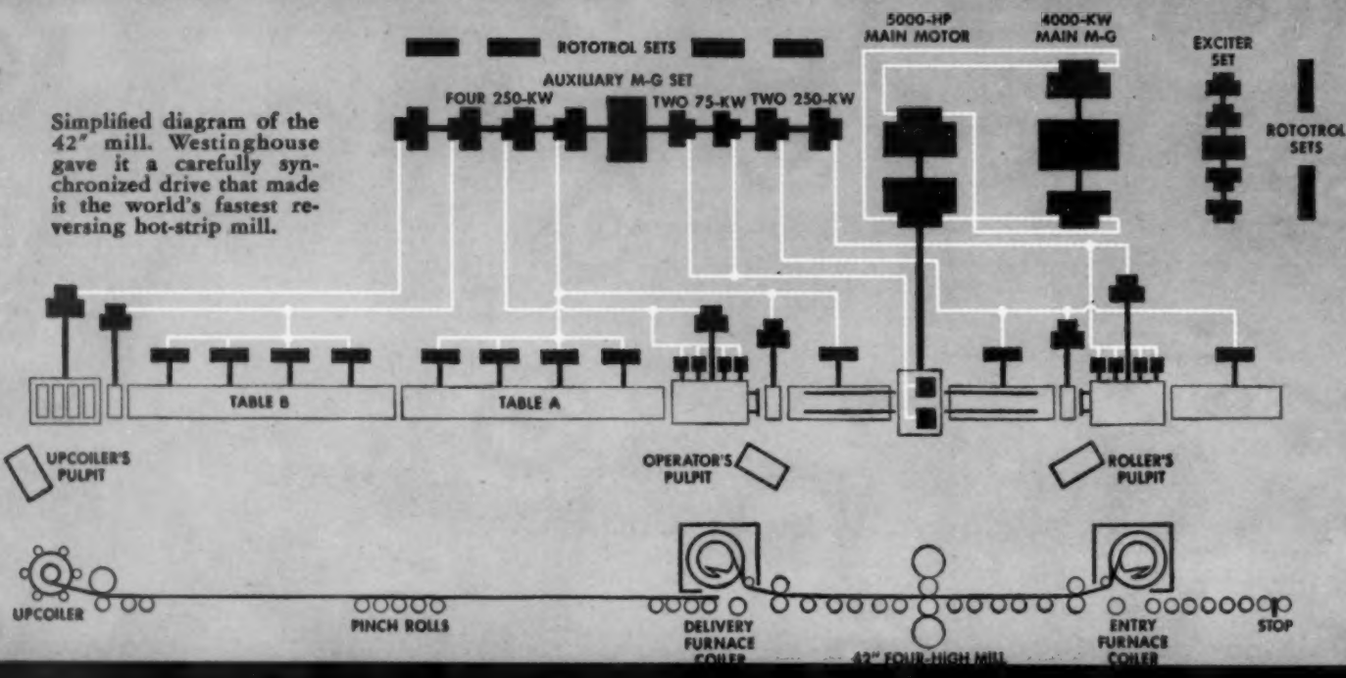
Branch offices in Chicago, Cleveland, Dayton, Detroit, Indianapolis, New Haven, New York, Philadelphia, Rochester, Toledo and Toronto, Canada. **West Coast Representatives:** Moore Machinery Company, Los Angeles and San Francisco; Star Machinery Company, Seattle. **Other dealers** in United States cities and throughout the world.

Remember:

for Presses, ROLLING MILLS, Special Machinery...

It's Bliss

They did what you can do to produce more



Simplified diagram of the 42" mill. Westinghouse gave it a carefully synchronized drive that made it the world's fastest reversing hot-strip mill.

Can you use hot-strip mill experience like this?

Five of the seven recent reversing hot-strip mill drives in U. S. mills have been built by Westinghouse. Here's a good example—a mill installed in 1949 that was *50% faster* than any previous mill.

An exceptionally high-speed reversing mill

This mill has been highly successful. Theoretical maximum speed is 2,000 fpm and it has operated at more than 1,500 fpm. A complete ingot can be reduced to strip in one piece and the mill regularly produces coils weighing 16,000 to 20,000 lbs. Finished thicknesses range from 0.125″ down to 16 gauge.

Special double-armature motor for main stand

Engineering the drive for this mill presented tricky problems. To accommodate the high speeds and wide speed range, Westinghouse developed a special double-armature motor, each unit of which is supplied by its own d-c generator. Both these generators are driven by a synchronous motor. A second M-G set is used to supply the auxiliary drive.

Main and auxiliary drives synchronized

When the strip leaves the roll stand it races into a narrow groove in a furnace coiler mounted near the mill. This demands the most precise synchronization between main drive and auxiliary drive. Westinghouse answered the need by carefully matching all drive elements and co-ordinating the whole system with Rototrol® regulators.

Call Westinghouse early on your next project

Westinghouse can apply more experience to drives for reversing hot-strip mills than any other manufacturer. And that's typical of our steel mill service. When your next job comes up, call in Westinghouse early.

J-94911

YOU CAN BE SURE...IF IT'S

Westinghouse

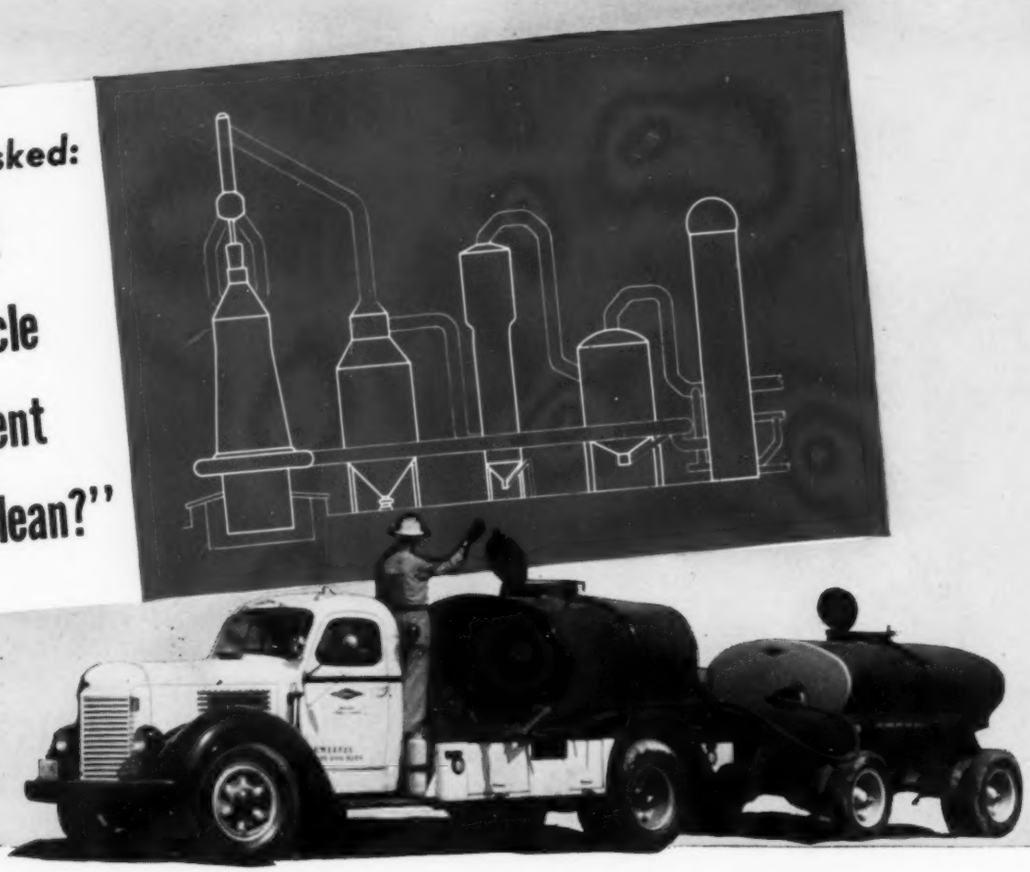
EQUIPMENT FOR STEEL PRODUCTION

DOWELL SERVICE

CHEMISTRY APPLIED TO MAINTENANCE CLEANING PROBLEMS

A Steel Mill asked:

"What Gas Cycle Equipment Can You Clean?"



DOWELL SERVICE has cleaned all types . . . FASTER . . . BETTER

Cleaning of blast furnace gas cycle equipment is a major Dowell Service to the steel industry. Practically every piece of equipment found in the cycle has been cleaned by Dowell Service.

Through the use of solvents, applied by special techniques, deposits can be removed faster and better than by mechanical methods. Dowell engineers are experts in the cleaning of industrial equipment. Dowell furnishes all necessary trained personnel, chemicals, pumps and controls. No special scaffolding is required. Dismantling and downtime are kept to a minimum . . . some equipment can be cleaned while in operation.

BLAST FURNACE COOLING SYSTEMS: Cooling coils and plates were cleaned by using Dowell solvent as coolant. Twenty sections were cleaned in one day, increasing cooling water flow five times.

ELECTROSTATIC PRECIPITATORS: By flooding weirs and ponds with Dowell solvent, caked dust and corrosion products were effectively removed. Dowell Service did the job in 12 hours, saving more than 177 hours over old-fashioned reaming and scraping.

GAS WASHERS: Instead of manual cleaning, Dowell Service pumped solvents directly into the scrubbing water without reducing wind on the furnace or otherwise interrupting operations. Washer was cleaned in four hours.

BLAST FURNACE STOVES: Gas heating efficiency of two stoves was raised from 63.6% and 64.6% to 82.7% and 79% by Dowell Service. The cleaning was accomplished *in four working days, without dismantling the stoves.*

GAS LINES: Another job was on the gas mains from washers to precipitators. Pressure drop on these 48″ and 60″ mains had increased to 17″ of water. Dowell Service cleaned all lines in 8 days bringing pressure drop down to 6″.

DUST COLLECTOR: Dust collector was picking up 5 tons per day instead of rated 30-40 tons. Instead of shut down and manual cleaning, Dowell Service cleaned the collector *in service*, increasing dust pick-up to 30-35 tons per day.

DOWELL INCORPORATED • TULSA 1, OKLAHOMA

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New York 20	Ft. Worth 2	Atlanta	Mt. Pleasant, Mich.
Boston 16	Chicago 4	Indianapolis	Hamilton, Ohio
Baltimore	St. Louis 8	Louisville	Charleston, W. Va.
Wilmington 99	Kansas City 8	Upper Montclair, N. J.	Salem, Illinois
Richmond 19	Wichita 2	Ardmore, Pa.	Beaumont, Texas
Jacksonville 2	Oklahoma City 2	Anniston, Alabama	Borger, Texas
Buffalo 2	Houston 2	Hattiesburg, Miss.	Midland, Texas
Cleveland 13	New Orleans 12	Lafayette, La.	Wichita Falls, Texas
Pittsburgh 19	Shreveport 69	Dearborn, Mich.	Hobbs, N. Mex.

★ *Maintenance cleaning service for industrial heat exchange equipment.*

★ *Chemical services for oil, gas and water wells.*

DOWELL

A Service Subsidiary of

THE DOW CHEMICAL COMPANY

Date-line Diary...

May 2

▲ Steel Co. of Canada ingot production in the first quarter of 1952 exceeded any previous output for a similar period.

▲ Inland Steel stockholders at their annual meeting approved the removal of a limitation of $400 a month on pensions under the company's pension trust.

▲ CIO president Murray called off the steel strike today and instructed the steelworkers to go back on their jobs.

▲ Both the government and the steel companies asked the Supreme Court to review Judge Pine's decision that the April 8th seizure of the steel industry was unconstitutional.

May 3

▲ Lead prices dropped 1¢ to 17¢ a lb in New York.

May 4

▲ Steel talks at the White House collapsed today.

May 5

▲ DPA reported that industrial expansion covered by certificates of necessity was 52 per cent in place on March 31, 1952.

▲ The AISI could report no operating rate for the steel industry because of the difficulties of scheduling caused by the steel strike.

May 6

▲ Standard Oil Co. of California signed a contract with an independent union providing an 18½¢ hourly boost for 5000 men.

▲ Price of industrial alcohol was cut to 57½¢ a gal from 75¢.

May 7

▲ AISI reports that the operating rate for the steel industry for the week beginning May 5, 1952 was 83.0 per cent of capacity. This is equivalent to 1,724,000 tons compared with 1,083,000 tons one week ago. Actual production for the previous week was 1,083,000 tons or 52.1 per cent of capacity.

▲ United States Steel Corp. elected Benjamin F. Fairless chairman of the board and chief executive officer. He succeeds Irving S. Olds.

▲ Federal Reserve Board suspended installment buying controls.

May 8

▲ Secretary of Commerce Sawyer reported that rise in employment this Spring has been somewhat less than a year ago.

▲ The Aluminum Association reports primary aluminum production for March of 154,138,528 lb. Shipments of sheet and plate totaled 81,189,387 lb.

▲ The ARCI reports new domestic freight car deliveries in April totaled 7403 compared with 8159 in March. Orders totaled 397 leaving a backlog on May 1 of 108,270.

May 9

▲ The AISI reported that hourly earnings for wage earners in the iron and steel industry averaged $1.95 in March. Employment was estimated at 672,100 and the total payroll was $242,731,000. Wage earners averaged 39.8 hrs per week.

▲ DPA ruled out the use of defense funds applied for by six steel companies wanting to spend $500,000,000 for expansion. Companies concerned were Kentucky Steel Corp., Central Iron and Steel Co., Detroit Steel Corp., Lone Star Steel Co., Trenton Steel Corp. and Tennessee Steel Corp.

May 10

▲ Commerce Dept. reports that imports in March totaled $963,000,000. March exports totaled $1,400,000,000.

May 12

▲ Based on reports of companies having 93 per cent capacity of the industry, the operating rate is scheduled at 100.3 per cent for the week beginning May 12, 1952. This is equivalent to 2,084,000 tons compared with 1,775,000 tons actually produced one week ago.

▲ Supreme Court started hearings on the government's seizure of the steel industry today.

▲ A Wall Street Journal study showed that first quarter earnings of 687 American corporations showed an average decline of 8.2 per cent from the like 1951 period.

May 13

▲ RFC announced that it had turned down the loan application of the Kentucky Steel Corp. and Central Iron and Steel Co. which would be used for additional expansion. Lone Star Steel withdrew its application. These companies were recently turned down by DPA.

▲ Lead prices dropped 2¢ to 15¢ a lb in New York.

▲ Arguments on the steel seizure case before the Supreme Court were completed today.

May 14

▲ Kaiser Aluminum and Chemical Corp. plan to expand aluminum production at Trentwood by 4,000,000 lb a month to 24,000,000 lb.

May 15

▲ CIO steelworkers passed a resolution at the union's biennial convention declaring steelworkers would not continue on the job indefinitely without a contract.

▲ General Services Administration, sole importer of natural rubber, reduced rubber prices 10½¢ to a 38¢ level.

▲ The Cabinet of Bolivia approved a decree which sets up a commission to study ways of nationalizing the tin industry.

May 16

▲ NPA ended its ban on the construction of entertainment and recreational facilities effective July 1. Other controls were also dropped.

▲ NPA announced that the steel industry has now a month's supply of scrap.

▲ Canadian newsprint producers were authorized by their government to raise their export price by $10.00 a ton to $126.00.

▲ CIO steelworkers approved increases of dues and initiation fees which will add $13,000,000 annually to the union's revenues.

May 19

▲ AISI reports that the operating rate of the steel industry for the week beginning May 19th is scheduled at 101.3 per cent of capacity or equivalent to 2,104,000 tons compared with 2,102,000 tons one week ago.

▲ The Commerce Department estimates gross national product for the first quarter was at an annual rate of $339,500,000,000. This is an increase of about $5,000,000,000 over the last quarter of 1951.

May 20

▲ Government suspended price ceilings on raw cotton and nearly all textiles.

May 21

▲ DPA Chief Fleischman was back of a third round of aluminum expansion officially recommended at a meeting of the three large aluminum producing companies.

▲ The Penn-Ohio Steel Corp. of Birdsboro, Pa. announced that it had acquired control of the Buhl Manufacturing Co. of Detroit.

▲ Jones & Laughlin Steel Corp. is cutting back its program of 106 new coke ovens at the Pittsburgh Works to 79 new coke ovens.

May 22

▲ At a meeting of the American Iron and Steel Institute in New York, officials predicted that steel production would fall below capacity toward the end of the year.

▲ United States government authorized price boosts on copper products.

May 23

▲ President Truman authorized copper withdrawals by 22,000 tons from the nation's strategic stockpiles. American firms are now allowed to buy Chilean copper at the world market price of about 35¢ a lb. Previously U. S. producers were buying copper at 27½¢ under a special agreement with Chile in which Chile was selling 80 per cent of its copper output to the U. S.

▲ Crucible Steel Co. of America charged that a group of dealers had swindled it of $300,000 by upgrading shipments.

May 26

▲ Based on reports from companies having 93 per cent of the capacity of the industry, the operating rate for the week beginning May 6 is scheduled at 102.3 per cent of capacity. This is equivalent to 2,124,000 tons compared with an actual production of 2,134,000 tons one week ago.

▲ The Small Defense Plants Administration and the Defense Production Administration announced a policy by which a specific portion of an expansion program can be reserved exclusively for small business.

▲ Jess Larson, head of the Defense Materials Procurement Agency, announced that government metal and mineral expansion program has made substantial progress.

▲ The F. W. Dodge Corp. announced contract awards in the thirty-seven states east of the Rockies of $1,597,517,000 for April, an increase of 21 per cent over March and 16 per cent more than April, 1951.

May 27

▲ The Department of Commerce and Labor predicted that construction outlays for 1952 may set a new record of more than $32,000,000,000. This is about $1,000,000,000 more than the figure for 1951. Of this, $21,000,000,000 will be spent by private concerns and $11,000,000,000 by the government.

▲ American Institute of Steel Construction reports April bookings of fabricated structural steel dropped 9 per cent from the previous month. These bookings totaled 205,022 tons compared with shipments of 230,874 tons. Backlog on April 30 totaled 2,350,974 tons.

▲ A report was made to Congress that the Aluminum Co. of America, Kaiser Aluminum Corp. and the Reynolds Metal Co. would be willing to add 300,000 tons yearly to their aluminum producing capacity if the government would agree to underwrite their market.

May 28

▲ The NPA granted civilian goods producers substantially increased metal rations for third quarter use.

▲ A group of underwriters offered $55,000,000 of 3⅛ per cent debentures of the National Steel Corp. at 99¾ plus accrued interest. About $41,000,000 will be used for redemption of mortgage bonds and the rest for general corporate purposes.

May 29

▲ Commerce Department reports that manufacturers' sales in April rose to $23,000,000,000. Inventories on April 30th totaled $42,500,000,000, up slightly from the $42,300,000,000 at the beginning of the month.

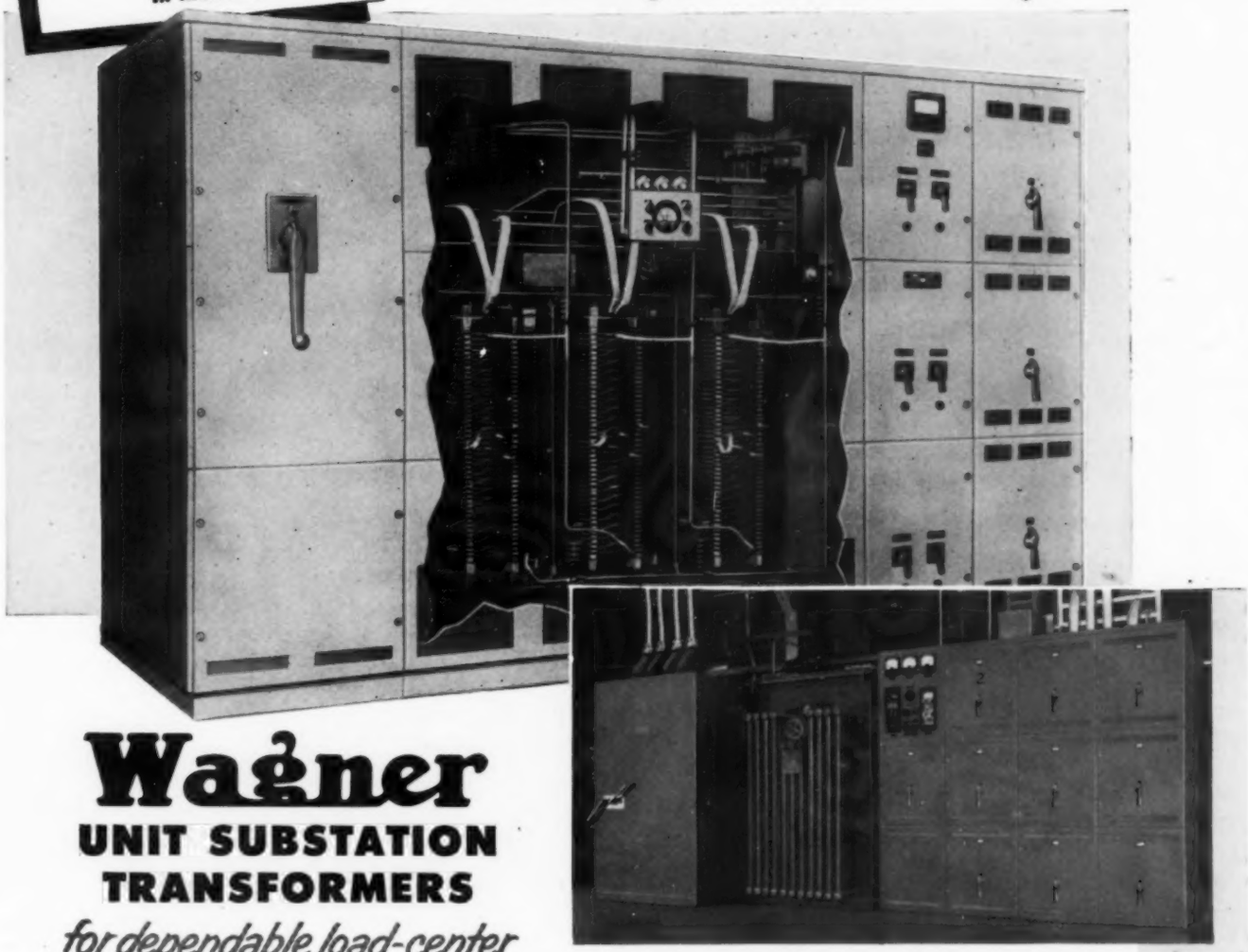
May 31

▲ The government set up officially a civilian stockpile which will operate in addition to the nation's military stockpile. As a start the DPA authorized the purchase of 30,000 tons of lead by the end of the year.

▲ Jess Larson, chief of the Defense Material Procurement Agency, announced a purchase program for concentrates and ores of columbium and tantalum. Government will pay a bonus as an incentive to production that will practically double the market prices of these metals.

Wagner
TRANSFORMERS
...the choice of leaders in industry

always specify...



Wagner
UNIT SUBSTATION TRANSFORMERS
for dependable load-center power distribution

Oil filled and non-inflammable liquid filled (Noflamol) transformers are available with various types of entrances and controls for high-voltage circuits, and with throats on the secondary side, in ratings up to 2000 kva.

The importance of the transformers in your plant power distribution system cannot be over-emphasized. If a switch or a circuit breaker fails, only a part of the system is affected—but if the *transformer* fails, the entire system is dead. Wagner Unit Substation Transformers assure a continuous, dependable flow of power.

Wagner three-phase dry-type load-center transformers are built in ratings through 2000 kva in the 15-kv class and below. Transformer and incoming line section are housed in compact factory-matched enclosures, designed for direct connection to matching secondary switchgear to form a closely coupled unit substation that is streamlined in appearance and readily accessible. Complete enclosure of all equipment assures safety against contact with live parts.

Wagner Dry-Type Unit Substation Transformers are for indoor installation in dry, clean, well ventilated locations. Because of their relatively light weight they can be used in multi-story buildings. Wagner Liquid-Filled Unit Substation Transformers are available for indoor or outdoor installation.

Bulletins TU-56 and TU-13 give full information on Wagner Dry-Type and Liquid-Filled Substation Transformers. Write for your copies.

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Use Ohio Rolls to step up your mill production.
Choose from 11 types of Ohio Iron and Steel Rolls:

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- Ohioloy Rolls
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- Denso Iron Rolls
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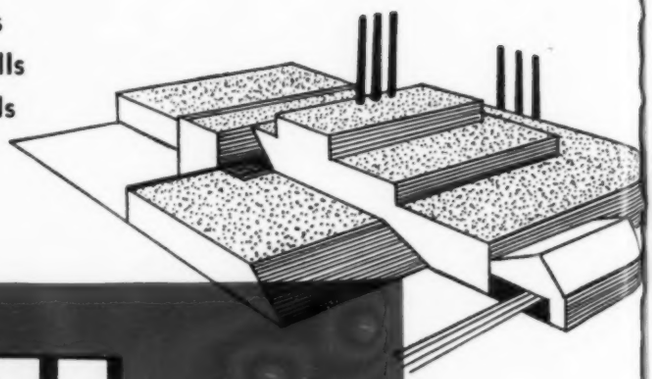
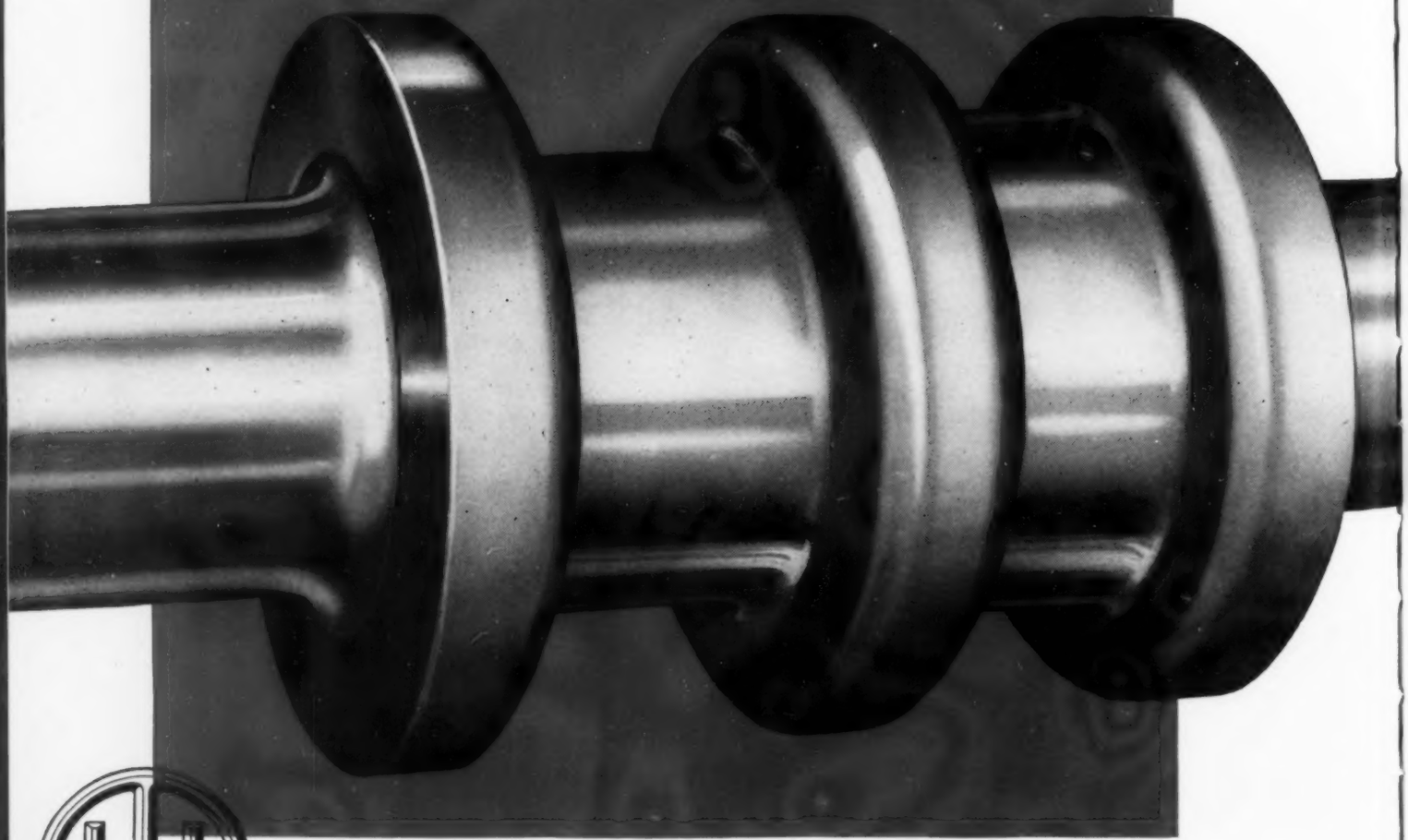
- Special Iron Rolls
- Nioloy Rolls
- Flintuff Rolls
- Ohio Double – Pour Rolls



Ohio Rolls

SHAPING METAL FOR ALL INDUSTRY



THE OHIO STEEL FOUNDRY CO.

LIMA, OHIO • PLANTS AT LIMA AND SPRINGFIELD, OHIO

Industry News...

PENNSYLVANIA RAILROAD CO. BUILDS ORE UNLOADING PIER IN PHILADELPHIA

▲ Contracts for the machinery to operate its new ore unloading pier in the Delaware River have just been signed by the Pennsylvania Railroad, as preparatory work on the site of the new facility at Greenwich Point, in South Philadelphia, Pa., progresses to the point where actual construction of the $8,000,000 pier can begin.

Hundreds of the 1,210 reinforced concrete piles which, starting later this month, will be driven into the river bed to provide a base for the pier structure, have been co.npleted in assembly line operations at the scene. Dredging of the river for 850 feet out from the shore line has been completed, the railroad announced. The pier is being built just north of the railroad's coal dumper and yard tracks, switches and other operating facilities are now under construction as support for the vast new operation.

The machinery contracts are for two unloading machines and a conveyor belt system to handle the pier's initial rated capacity of 2,400 tons of ore an hour.

The unloading machines will be built by Industrial Brown Hoist Co., and Heyl and Patterson, Inc., has been awarded the contract for the conveyor belt system. A bucket on each machine will lift 17 tons of ore at a bite and unloading cranes, to which they will be attached, will have a reach of 72 ft on each side of the pier. The two 54-in. belt conveyors will each be 1,600 ft long and will have a maximum capacity of 4,410 tons per hour.

Heyl and Patterson also will build the carloading house to which belts will bring the ore for handling through steel bins and hoppers to railroad cars.

The railroad plans to place the ore unloading pier in service by the summer of 1953. It will be equipped to handle two ships at once, with provision to expand capacity ultimately to handle four ships simultaneously. The pier is designed to handle iron ore enroute to steel mills in this country from new sources of supply now being developed in Venezuela, Brazil, Chile and Labrador, as well as other foreign ore.

RANDALL IS HONORED FOR REBUTTAL SPEECH

▲ Clarence B. Randall, president, Inland Steel Co., Chicago, Ill., who spoke for the steel companies in the steel wage case April 9 in reply to charges made by President Truman, was honored at the 60th General Meeting of American Iron and Steel Institute, May 22, in New York, N. Y.

Mr. Randall, whose nationwide radio and TV address was titled, "These Are the Facts, Mr. President," was given a citation from the Board of Directors of the Institute as 1200 steel executives applauded. The presentation was made by Walter S. Tower, president of the Institute, on behalf of the directors.

The framed, illuminated scroll said: "For conspicuous and courageous service to the steel industry and broadly to all private enterprise in this country in a time of severe stress, this citation is given to Clarence B. Randall, in grateful acknowledgment and high appreciation, by resolution of the Board of Directors of American Iron and Steel Institute." It was signed by Mr. Tower and by George S. Rose, secretary of the Institute.

ATLANTIC STEEL STARTS ELECTRIC FURNACE PLANT

▲ The southeast's largest electric furnace was placed in operation on May 13 by the Atlantic Steel Co., Atlanta, Ga. The new 60-ton furnace, with its annual capacity of 112,000 tons of steel will increase the company's output by more than 50 per cent.

Dedication ceremonies were attended by more than 150 leaders from business, industry, labor, government and the Armed Forces.

Robert S. Lynch, president of Atlantic Steel Co., said the new furnace and plant was visible evidence of the company's and employees' faith in the continued progress of the South. He said the increased production will materially aid the company in meeting the steel requirements of both national defense and civilian needs.

The new plant, built at a cost of $2,500,000, is built on a 9-acre plot, adjacent to the company's three 75-ton open hearth furnaces, rolling and finishing mills.

The building housing the furnace was fabricated and erected by the Bethlehem Steel Co. It is 200 ft long, 130 ft wide, and 90 ft high. Crane-

Aerial view of the vast production line operation on the site of the Pennsylvania Railroad's new ore unloading pier at Greenwich Point on the Delaware River, where 1210 reinforced concrete piles are being cast (center and right foreground). The piles, 20 in. square and up to 89 ft long, will be driven into the bed of the river as the base for the new pier, which is expected to be ready for service during the summer of 1953.

The hard, cold facts about Pittsburgh's hot furnaces!

47 PLANTS OKAY THE HEAT PROVER

Pittsburgh's great steel industry needed an instrument to measure air infiltration, to check air requirement and fuel-air ratio controls in open-hearth furnaces . . . an instrument to check the stoves in which blast-furnace air is heated . . . to check precise atmospheres in soaking pits . . . to control fuel waste and precise atmospheres in processing furnaces.

THE CITIES SERVICE HEAT PROVER WAS THE ANSWER . . . and it received the stamp of approval from engineers in 47 different mills in and around Pittsburgh!

Cities Service Heat Provers . . . *not an instrument you buy, but a service we supply* . . . helped to boost furnace productivity through these five unique advantages:

1. Rapid continuous sampling.

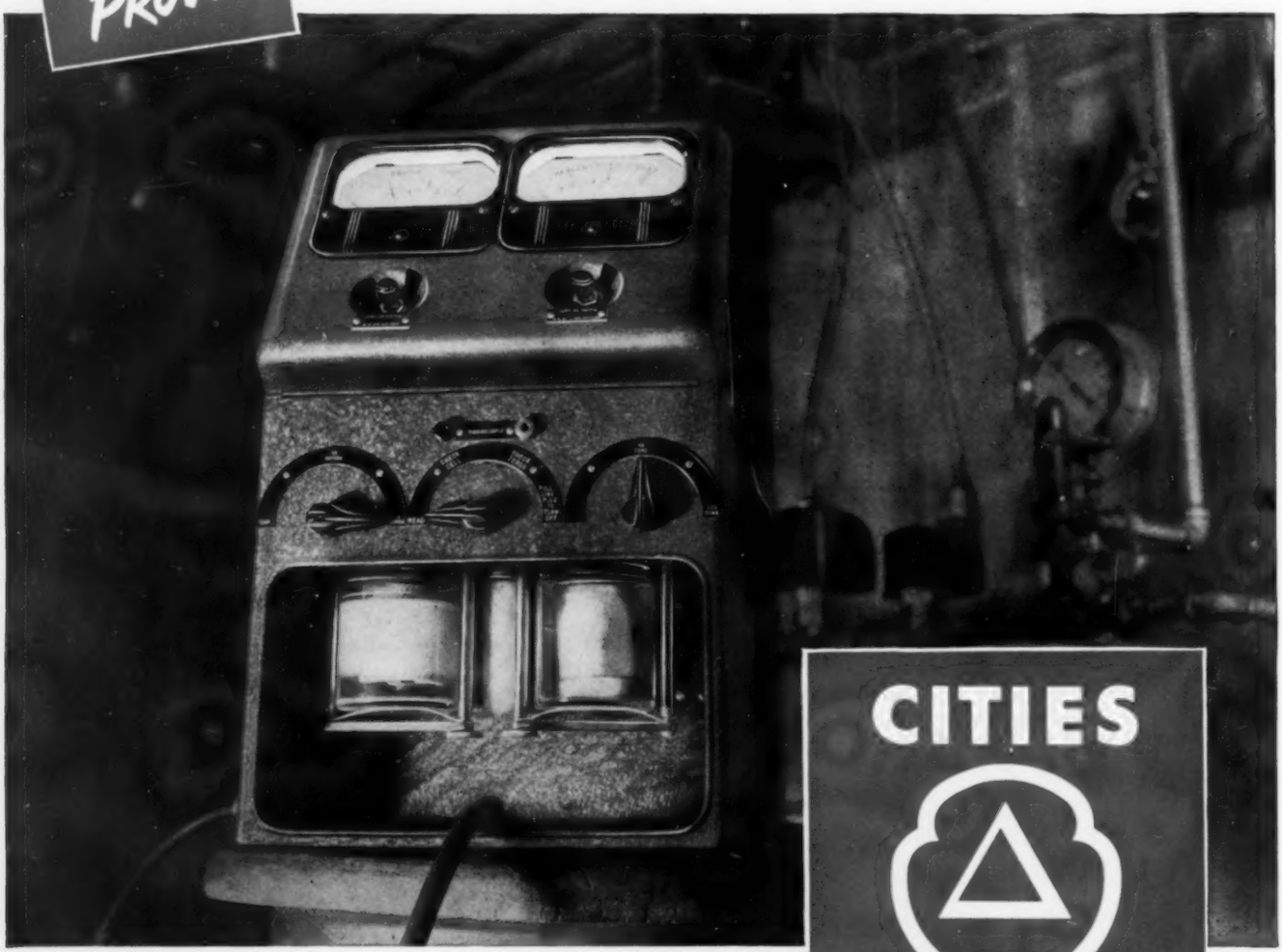
2. Simultaneous reading of oxygen and combustibles.

3. Direct measurement of oxygen and combustibles.

4. Easy portability.

5. No maintenance; no re-calibration.

These points begin to tell you why Cities Service Heat Prover analyses are just as much favored in glass, ceramics, steam generation and other fields as in the great Pittsburgh steel area. For the full story as it applies to you, write CITIES SERVICE OIL COMPANY, Dept. F-17, Sixty Wall Tower, New York City 5.



CITIES SERVICE

ways extend an additional 260 ft on one end and 60 ft on the other end of the building. Footings for the structure extend to a maximum depth of 28 ft. Approximately 3600 cu yd of concrete and 1700 tons of structural steel were used in the construction.

The electric furnace, designed and built by the Pittsburgh Lectromelt Furnace Corp., is known as a top-charge basic-lined model "JT Lectromelt." It has a rated capacity of 60 tons, although it is capable of producing 75 tons of steel ingots per heat. The furnace measures 9 ft 6 in. from the floor level to the roof ring. Diameter of the shell is 18 ft, and its internal capacity is 1750 cu ft. Four to six hours are required to produce a heat of steel.

The furnace will use more than 6,500,000 kw hr of electrical power per month—more than a city of 40,000 population. A new sub-station was built especially to bring power to the plant. It is supplied to the furnace through a transformer rated at 18,000 kva.

Since pig iron is not required in the making of electric furnace steel, scrap alone is charged. This scrap is loaded directly from railway equipment into charging buckets which have as much as 1400 cu ft capacity.

In charging the furnace, the roof and electrode assembly swing to one side, permitting the scrap to be dropped directly into the furnace from the bucket, which is suspended from an overhead crane. The roof is then replaced and the three graphite electrodes, each 20 in. in diameter and 18 ft long, are lowered into the furnace. The scrap is melted and refined by the arcing of high voltage electrical current through the electrodes and the scrap, which raises the furnace temperature as high as 2950 F. Later, one or more additional scrap charges are necessary to utilize the full capacity of the furnace.

After the melt is completed, and the steel is of the proper chemical analysis, the entire furnace is tilted forward, pouring the molten steel through a spout into a huge ladle capable of holding 80 tons of steel.

The ladle is then suspended over the ingot molds, and the molten metal is permitted to flow into the molds through a nozzle. The ingots solidify, are stripped from the molds and are then ready for further processing.

Supplementing Atlantic Steel Co.'s

Mathews Engineering

-paying off in increased production ...

● Keeping material moving through plant processes is a job for conveyers and conveyer systems. When workers must leave their machines for trips to their source of material, time and production are lost. Modern conveyer systems bring materials to machines, into them and out again, with a minimum of handling by operators. They devote their entire energy to running their machines in their best and most efficient manner.

Your nearest Mathews' Representative would be glad to help you lay out a fast, efficient production line. Write for more information today.

MC

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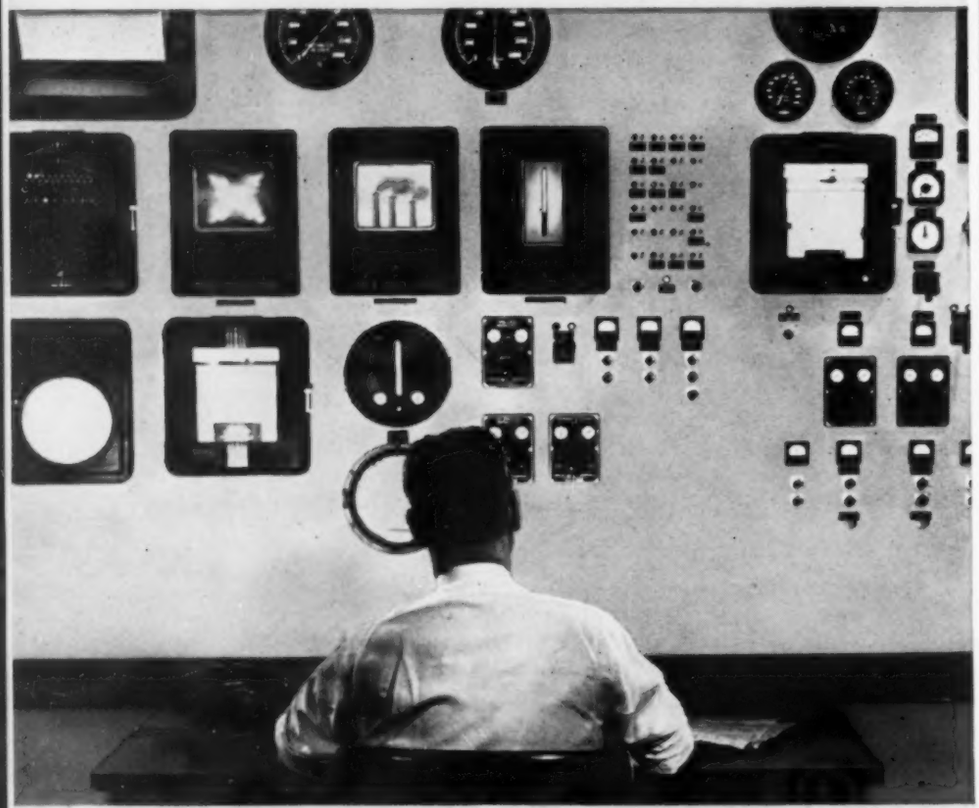
DIAMOND "UTILISCOPE"

(WIRED TELEVISION)

improves Centralized Control

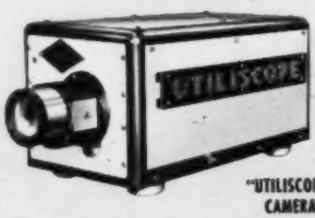


Operator in central control room of large power station "SEES WHERE HE CAN'T LOOK". Here he watches flame conditions in boiler furnace, stack smoke discharge, and water level in boiler on "Utiliscope" screens of control panel.

Centralized control is much more effective if it brings a SENSE OF REALISM into the control room . . . if the operator can actually see what is going on outside his range of vision instead of depending upon indirect interpretations of operating conditions. The electric power industry has accepted the "Utiliscope" as an important factor in achieving better centralized control (as shown above).

The "Utiliscope" has many other uses in industry where its low cost is quickly amortized by improved operation, greater safety or savings in labor. It is surprisingly simple and requires no special skill for installation and operation. Stability and reliability are exceptional. For information on a wide variety of cost-cutting operations, ask for Bulletin 1025E

"UTILISCOPE" RECEIVER

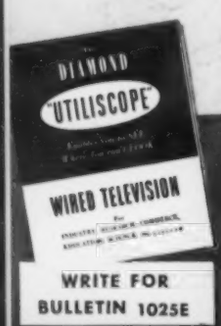


"UTILISCOPE" CAMERA

OTHER USES—Watching flow of molten metal • Studying destructive tests of engines Viewing nuclear research • Coordinating materials flow on conveyors.

The "Utiliscope" (Registered U. S. Patent Office)

4743



WRITE FOR BULLETIN 1025E

DIAMOND POWER SPECIALTY CORP.

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Diamond Specialty Limited — Windsor, Ontario

Since 1903, Diamond has Manufactured Quality Equipment For Industry

three open-hearth furnaces, which have an annual rated capacity of 188,000 tons, the new electric furnace increases the company's total steel output to 300,000 tons annually.

KAISER EXPANDS FOIL MILL IN CALIFORNIA

▲ Expansion of its Permanente, Calif., aluminum foil mill to increase production capacity 50 per cent and manufacture foil of wider dimensions was announced by Kaiser Aluminum & Chemical Corp.

The plant's capacity will be boosted from 12,000,000 lb to 18,000,000 lb per year, and the range of available foil widths will be nearly doubled, allowing the mill to produce the widest foil in current use.

New construction and installation of additional equipment will begin in the near future and is scheduled for completion early next year.

The expansion will include increasing the plant's floor space approximately 25 per cent, installation of a new four-high, 60-in. high speed mill capable of rolling foil at 3,000 fpm, and additions to roll grinding equipment, doubling mills, separators, slitters and handling equipment. Operation of the mill at its new capacity would necessitate an increase in plant personnel up to 35 per cent.

ROTARY KILNS

Two new rotary kilns, said to be the largest in the refractory industry, (390 ft long, 11 ft diam) are being installed at the Maple Grove, Ohio plant of Basic Refractories. Each kiln shell is made of 7/8 in. steel and weighs about 300 tons. Shells ride on six cast steel riding rings (172 in. outside diameter and 26 in. face width). With motor operating at maximum speed of 1200 rpm, kiln will rotate at 1.5 rpm.

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OF ROLL MAKING

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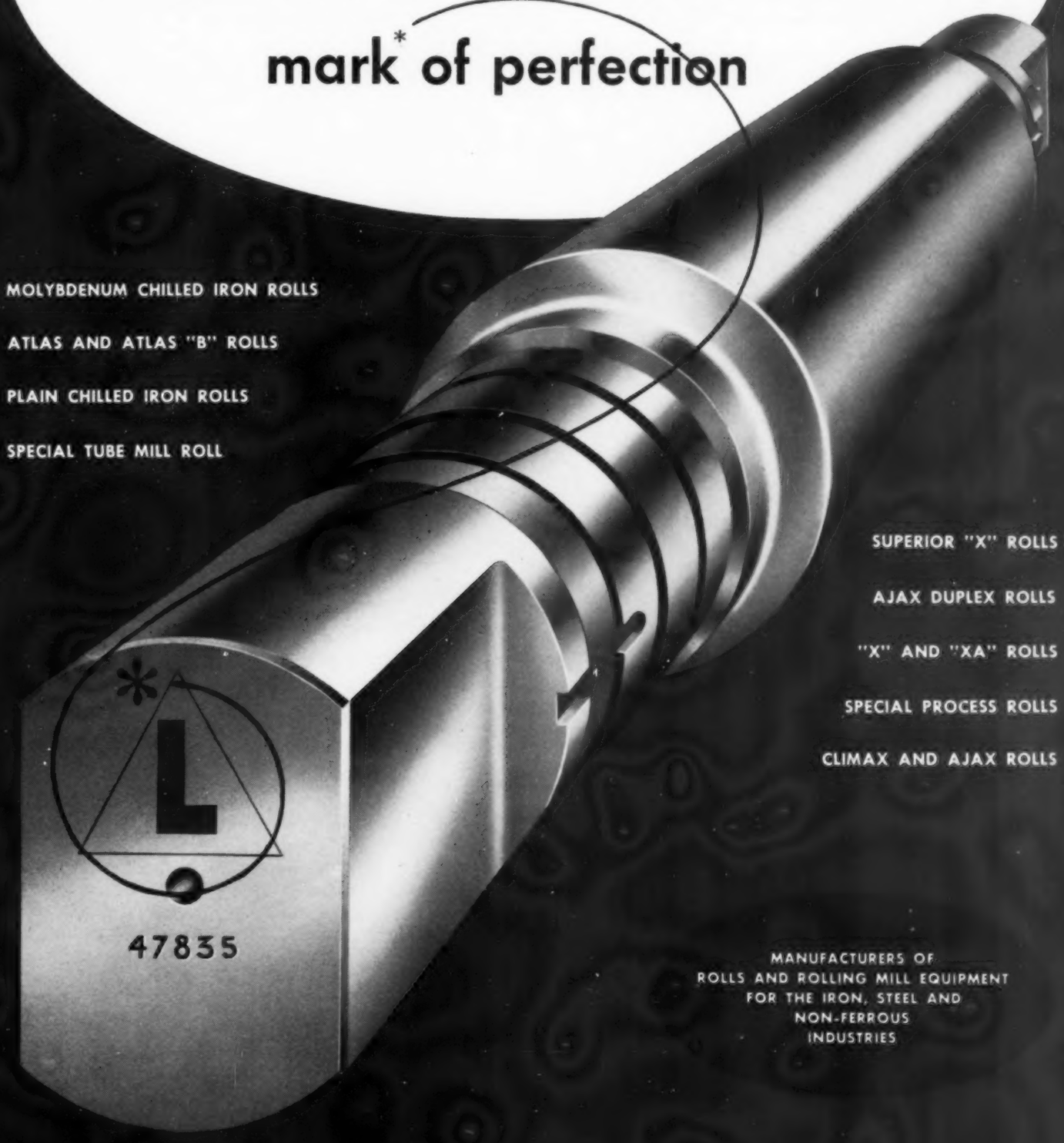

MOLYBDENUM CHILLED IRON ROLLS

ATLAS AND ATLAS "B" ROLLS

PLAIN CHILLED IRON ROLLS

SPECIAL TUBE MILL ROLL

SUPERIOR "X" ROLLS

AJAX DUPLEX ROLLS

"X" AND "XA" ROLLS

SPECIAL PROCESS ROLLS

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ROLLS AND ROLLING MILL EQUIPMENT
FOR THE IRON, STEEL AND
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FEATURING:

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You can save REAL money on the operation of electric trucks. Ready-Power DIESEL-Electric drive is the answer. Actual tests prove savings of 40% to 70% in operation and maintenance. Rugged DIESEL design provides *more* work per gallon of fuel, *longer* life span and *less* maintenance. And Ready-Power DIESEL-Electric Units provide the most efficient, most constant, most economical power source for electric industrial trucks.

Remember...Your Truck Is No Better Than Its Power!

CONTINUOUS-DUTY POWER UNITS

The READY-POWER Co.

3836 Grand River Ave., Detroit 8, Michigan

Manufacturers of Gas and Diesel Engine-Driven Generators and Air Conditioning Units; Gas and Diesel-Electric Power Units for Industrial Trucks

B & W MOVES OFFICES IN NEW YORK CITY

▲ Babcock & Wilcox Co., nation's largest producer of steam generators and related equipment, recently opened new headquarters in the recently completed 32-story fully air-conditioned Chrysler Building East at 161 East 42nd St., following one of the largest moves from the financial district in many years. Sales offices of Babcock & Wilcox Co.'s Tubular Products Division will not be affected by the move, and will remain in their present location at 22 East 40th Street.

The company has a research center, and eight manufacturing plants, in Ohio, western Pennsylvania, Georgia, Mississippi, North Carolina and Texas. It employs approximately 14,000 people, of which 825 are in the New York office. Its products are separated into five general groups—stationary boilers, marine boilers, tubes, refractories, and special products.

ASKANIA APPOINTS WEST COAST AGENTS

▲ Askania Regulator Co., Chicago, Ill., has announced the appointment of Heat & Control, Inc., as its West Coast representative. Heat & Control's headquarters are at 270 Seventh St., San Francisco, Calif. They will handle the complete Askania line of hydraulic automatic control equipment.

WESTINGHOUSE RECEIVES LARGE KAISER ORDER

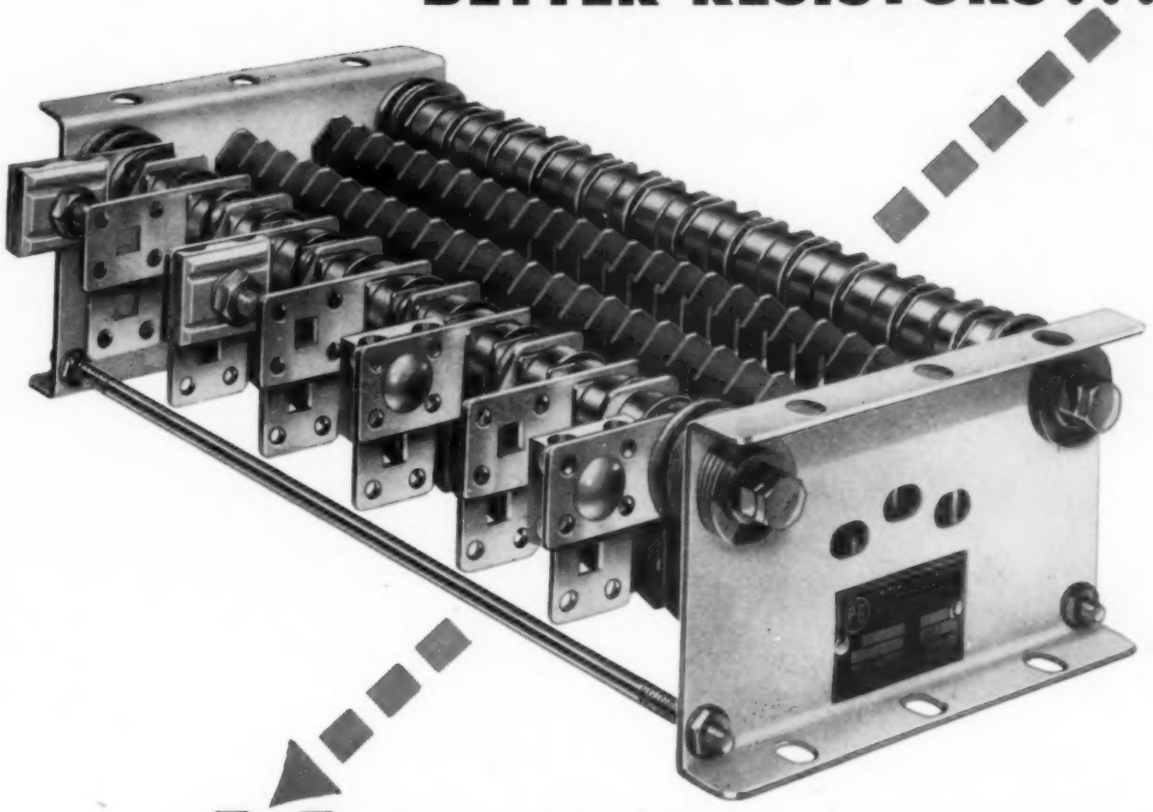
▲ Westinghouse Electric Corp. has reported receipt of an order for approximately $9,000,000 worth of electrical equipment from Kaiser Engineers, Oakland, Calif., for four new pot lines at the Chalmette aluminum reduction plant of the Kaiser Aluminum & Chemical Corp. Addition of these lines will give the Chalmette plant, located near New Orleans, La., a total of eight pot lines and will double the plant's capacity.

The order includes four 72,000-amp, 750-volt d-c rectifier units, one for each of the four pot lines. Each

(Please turn to page 144)

SEVERE MILL SERVICE *Demands*

BETTER RESISTORS...



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These features, plus accurate resistance values and ample capacity ratings, make P-G the *better resistor,* capable of solving your resistor problems. Specify P-G for your next application, especially, if your operating conditions are *severe.*

Write for Bulletin No. 500

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PHOENIX "A" Alloy Steel ROLLS are color marked for specific uses in rolling . . .

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Phoenix "A" Alloy Steel
Phoenix "A" Special Alloy Steel

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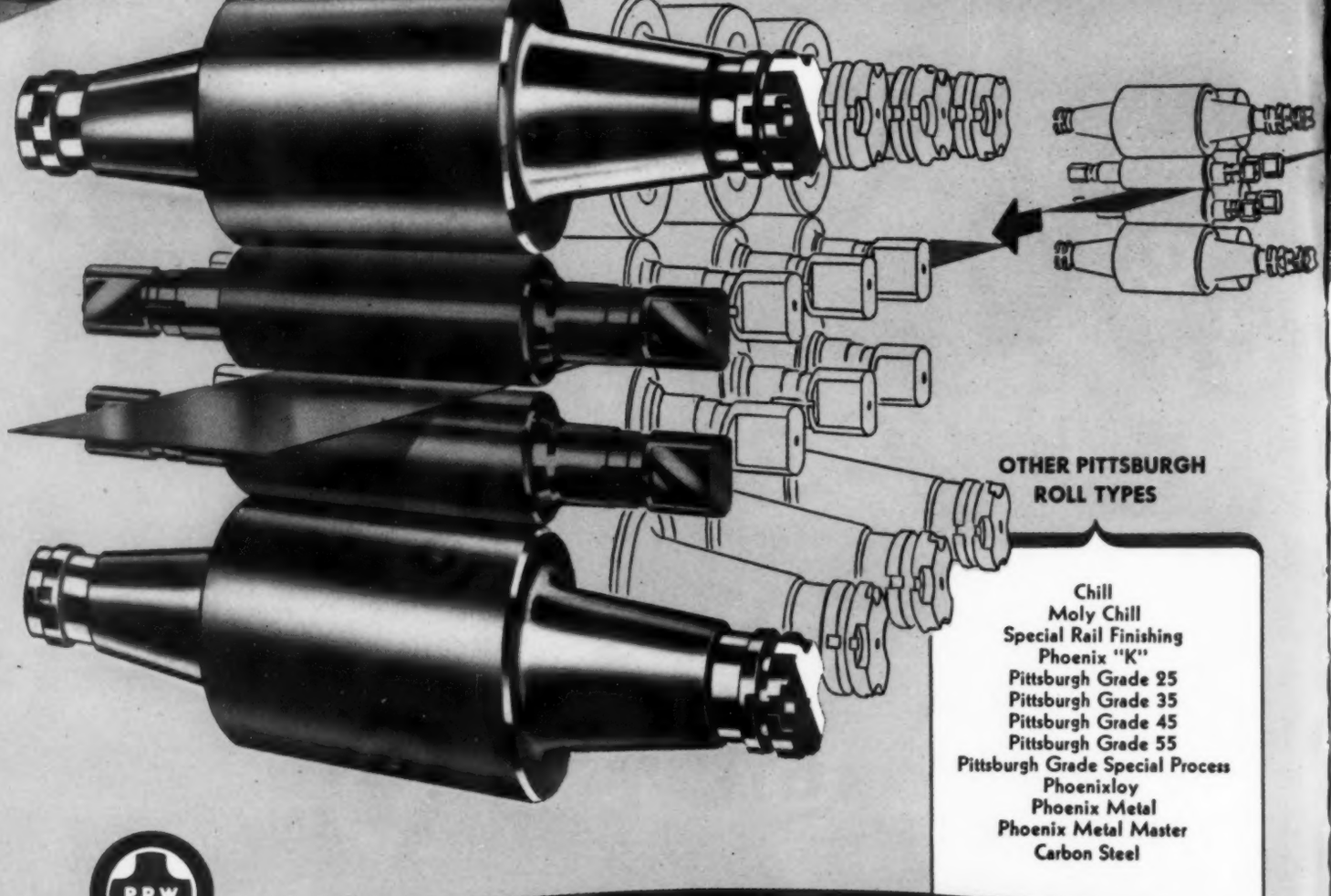

OTHER PITTSBURGH ROLL TYPES

Chill
Moly Chill
Special Rail Finishing
Phoenix "K"
Pittsburgh Grade 25
Pittsburgh Grade 35
Pittsburgh Grade 45
Pittsburgh Grade 55
Pittsburgh Grade Special Process
Phoenixloy
Phoenix Metal
Phoenix Metal Master
Carbon Steel

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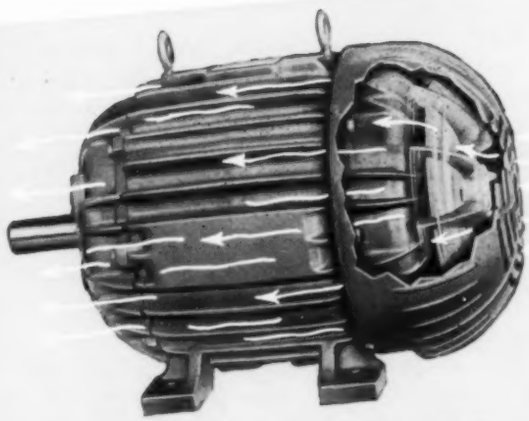
PITTSBURGH ROLLS

PITTSBURGH ROLLS DIVISION of BLAW-KNOX COMPANY • PITTSBURGH, PA.

BEST BET
for heavy duty mill and crane service—

ELLIOTT Crocker-Wheeler
600 SERIES MILL MOTOR

■ Concentrated toughness is built into this motor. Not only will it stand the gaff of constant, heavy service, but due to superior engineering, it packs as much as 1/3 more power in each standard size frame. Split frame allows quick access to bearings, armature, field coils. From 5 to 265 hp. Also available *separately forced-ventilated, protected self-ventilated, back-geared.* Write for the Mill Motor Bulletin.



Popular for 11 Years!
ELLIOTT CROCKER-WHEELER SEALEDPOWER MOTOR

This totally enclosed fan-cooled induction motor keeps cool with a cowl-directed blast of air driven along its finned case. This air-stream carries off heat, and says "no parking" to dirt, dust, lint, etc. In 3 to 125 hp. Also available in vertical type, and in explosion-proof, underwriters approved, in most ratings. Ask for the Sealedpower Bulletin.

ELLIOTT Company

CROCKER-WHEELER DIVISION
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For large motors: RIDGWAY DIV., RIDGWAY, PA.
Plants at: JEANNETTE, PA. • RIDGWAY, PA. • AMPERE, N. J.
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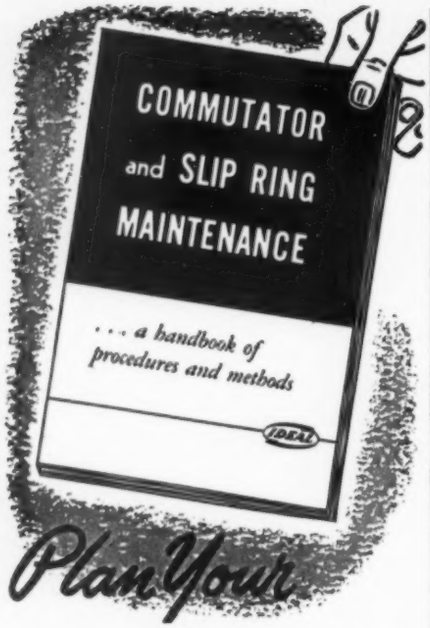
ELLIOTT APPROVED SERVICE SHOPS COVER THE COUNTRY

W2-11



MAINTENANCE PROGRAM *with this New* FREE HANDBOOK

The Commutator and Slip Ring Maintenance methods and procedures described have been proven over many years in hundreds of operations. They are based upon conclusive evidence compiled by well-known authorities. Concise, practical information tells everything you need to know about scores of commutator and slip-ring problems:

- **Commutator and slip ring troubles and how to correct them**
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- **Condensed data on IDEAL commutator and slip ring maintenance products**

Dozens of illustrations and diagrams show operations described. Every operating and maintenance man should have this guide to better, more efficient, lower cost maintenance. Mail coupon for your free copy.

LOOK TO IDEAL AS MAINTENANCE HEADQUARTERS FOR:

Resurfacers • Brush Seaters • Commutator Cleaning Stones • Grinders Mica Undercutters • Saws and Milling Cutters, etc.

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Please send me your free handbook on commutator and slip ring maintenance.

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COMPANY_____

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(Continued from page 141)

72,000-amp rectifier will be made up of six 12,000-amp units, each consisting of two 6,000-amp twelve-tank ignitron rectifier assemblies.

In addition to the rectifier units, Westinghouse will supply the transformers and associated switchgear to control the anode and cathode circuits of each 6,000-amp assembly, and will include centralized control and supervision apparatus for the 13.8-kv, 3-phase, 60-cycle circuit of each 72,000-amp unit.

Each of the four new lines has 144 pots and will produce 50 million pounds of aluminum per year, increasing the capacity of the plant by 200 million pounds per year.

The electrical equipment for the new plant is scheduled for delivery by December 1952, and all eight pot lines for the Chalmette plant will be in operation by early 1953.

CONSULTING FIRM OPENS NEW CLEVELAND OFFICES

▲ Fischer and Associates, consulting engineers, announce the opening of new offices at 5209 Euclid Ave., Cleveland, Ohio. Established a year ago with three employees, the firm now employs 35 engineers and has completed design work on cranes, steel mill and other process plant installations valued at $4,300,000.

The firm is under the direction of Hans F. Fischer, president, who held the post of open hearth engineer for all plants of Republic Steel Corp. from 1947-1950, and previously was senior engineer of Joy Manufacturing Co.

REINTJES ANNOUNCES NEW DISTRICT OFFICE

▲ Geo. P. Reintjes Co., Kansas City, Mo., announces the opening of a district office at 3530 Forbes St., in Pittsburgh, Pa. P. M. Offill, Jr., will be district manager.

BIRDSBORO FORMS NEW SUBSIDIARY FIRM

▲ Birdsboro Steel Foundry & Machine Co. announces the formation of a new wholly owned subsidiary, Birdsboro Armorcast, Inc., to make hull and turret castings for tanks. The new corporation will be one of the major suppliers for the Chrysler tank plant at Newark, Del.

In order to maintain the needed production level, Birdsboro has leased a plant adjacent to its present property from the Navy. The plant will be managed and operated by Birdsboro, with production and inspection supervised by the Philadelphia Ordnance District, with direct supervision under the Allentown regional office.

Officers of the newly formed corporation are J. E. McCauley, president; Marshall Post and G. Clymer Brooke, vice presidents; James M. Heppenstall, treasurer; and Lester E. Leinbach, secretary.

FAN MANUFACTURERS ELECT OFFICERS

▲ At the thirty-fifth annual meeting of the National Association of Fan Manufacturers, Inc. the following officers were elected for the ensuing year: R. A. Wasson, president; J. M. Frank, vice president; and L. O. Monroe, secretary-treasurer.

Mr. Wasson is vice president and general manager of the Clarage Fan Co., Kalamazoo, Mich., while Mr. Frank is president of the Ilg Electric Ventilating Co., Chicago, Ill.

VALVE RESEARCH CENTER OPENED IN PHILADELPHIA

▲ A research center has been established in Philadelphia by the valve division of Minneapolis-Honeywell Regulator Co. to support an extensive development program in industrial valves.

The test and research equipment, housed in a two-story brick building, will evaluate present valve design and performance as well as implement research into new valve types to parallel advances being made in modern process control, Keller said. An elaborate hydraulic laboratory is built into the Research Center to measure valve capacities and the static and dynamic internal forces of valves. More than 2,000 gpm of water can be pumped through the test stand under pressure up to 100 psi. High temperature testing equipment will measure the strength of valve components at temperatures up to 700 F.

An important phase of the research activity, Keller said, will be the de-

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this new engineering data book on thermocouples

You need this up-to-the-minute 56-page edition of Bristol's famous book if you're involved with thermocouples and pyrometers of any kind. It's free for the asking. Here's what you get in its three, fact-packed sections . . .

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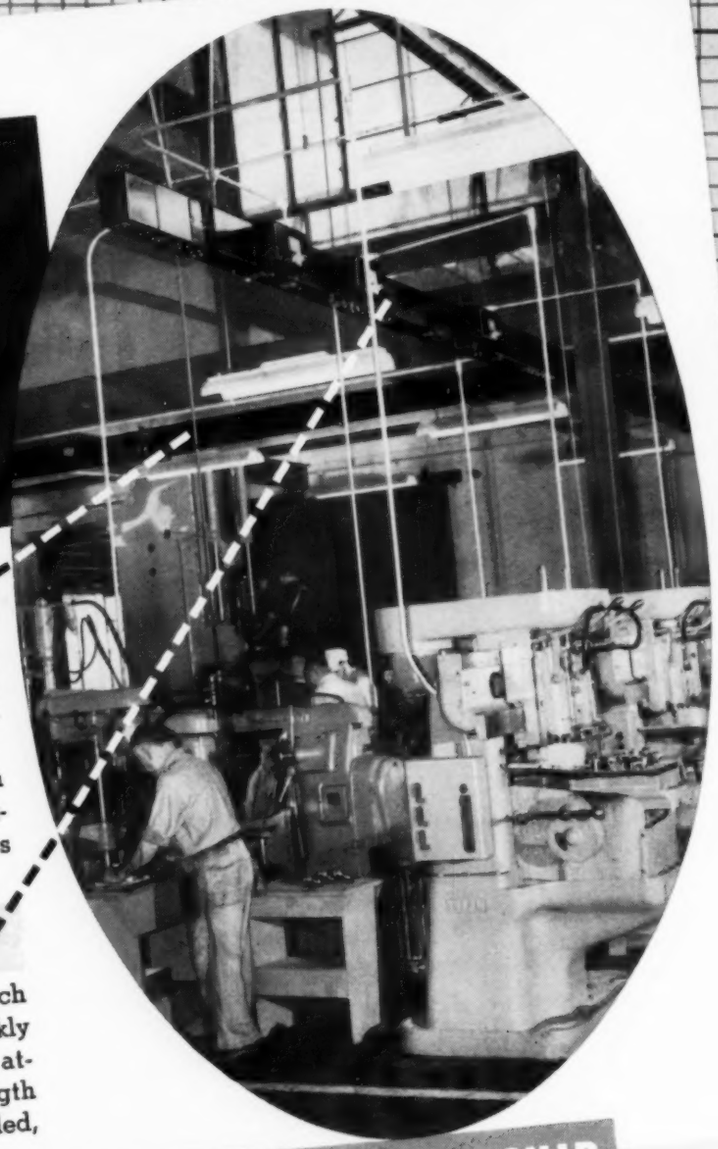
POWER DISTRIBUTION



SQUARE D FEED-IN DUCT

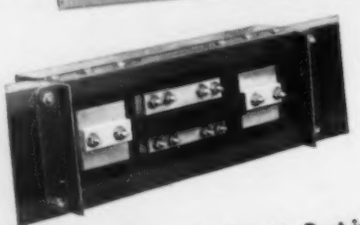
is the most efficient way to transmit large amounts of power. It provides the lowest known voltage drop—only 1.8 volts per 1000 amperes per 100 feet.

Exclusive design requires no ventilation—permits a totally enclosed, compact, dust-excluding enclosure. Rigid construction provides high resistance to heavy electrical stresses.

SQUARE D PLUG-IN DUCT

provides flexible power distribution for branch circuits. Machinery can be rearranged quickly at minimum cost. Plug-in units can be attached at frequent intervals along the length of the duct, providing power where it's needed, when it's needed.

BUSWAY FEATURES PROVE DESIGN LEADERSHIP



NEW JOINT DESIGN. Feed-in Duct joint design saves installation time and reduces maintenance cost. Duct ends are identical—unnecessary to select mating ends before positioning or hanging duct sections. Outward-facing, pre-installed bolts permit rapid assembly and easy maintenance.

ROUND BUS BARS for Plug-in Duct provide greater mechanical strength and resistance to short-circuit stresses. Circuit breaker or fusible type plug-in units are easily installed at 2-foot intervals along both sides of the duct. Plug-in stabs grip the round bus bars with exceptionally high pressure.

FLEXIBLE CONNECTORS of laminated copper join bus bars between sections—permit proper alignment, insure tight joints and provide for expansion and contraction at Plug-in duct joints. All bolt heads face outward for greater accessibility.

ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS

SQUARE D COMPANY

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SQUARE D COMPANY CANADA LTD., TORONTO • SQUARE D de MEXICO, S. A., MEXICO CITY, D.F.

termination of the suitability of substitute valve materials proposed to relieve the critical alloy situation.

A modern model shop supports the diversified research program.

TO BUILD SLAB FURNACE AT TUBE DIVISION

▲ A new slab heating furnace will be constructed for National Tube division of United States Steel Co. to serve its new pipe mill at Morrisville, Pa., according to Rust Furnace Co., the designer-constructor.

The furnace is a Rust continuous type slab heater. Slabs will be side charged and side discharged.

A double-zone, recuperative type, the new unit will be equipped for top firing by either coke oven gas, natural gas, and oil. It will have a 43-ft width inside with an effective heating length of 60 ft, and will be provided with full automatic controls for combustion, furnace pressure and temperature.

DAMASCUS TUBE CO. NAMES REPRESENTATIVES

▲ Damascus Tube Co., Greenville, Pa., announces appointment of the following sales representatives and the division of their respective territories: S. E. Anning Co. of Cincinnati, Ohio, will cover the entire states of Kentucky and Tennessee, plus southern Ohio and southern Indiana. Denton & Anderson Co., with offices in Detroit, Mich., and Cleveland, Ohio, will be responsible for eastern Michigan, northern Ohio and northwestern New York. H. W. Mollison of Pittsburgh, Pa., and P. L. Fair of Philadelphia, Pa., will cover Delaware, Maryland, Pennsylvania, West Virginia, New Jersey and eastern New York. Steel Mill Products Co. of Chicago, Ill., will cover Iowa, Minnesota and Wisconsin, plus western Michigan, northern Indiana and northern Illinois. R. E. Schlendorf Co., San Francisco, Calif., will handle California.

BETATRON PLANT TO BE COMPLETED THIS MONTH

▲ Construction is expected to be completed sometime in June on a new 86 by 74-ft concrete building at the West Allis, Wisc., works of Allis-

Maybe your business isn't LUMBER . . .

. . . or PINEAPPLES

BUT . . . just imagine the savings you could make, the problems you could solve by handling your materials with ROSS Straddle Carriers, the most flexible and most adaptable mass material handling method known!

ROSS engineers will be glad to work with your materials handling men in exploring the possibilities of ROSS Straddle Carriers for your operations . . . there's no obligation.

Send for details on ROSS Straddle Carriers . . . 10,000 lb., 20,000 lb., 35,000 and 45,000 lb. capacities.

Rely On ROSS

THE ROSS CARRIER COMPANY

Direct Factory Branches and Distributors throughout the world.

400 Miller St., Benton Harbor, Michigan, USA

Chalmers Manufacturing Co. to house a 22-million volt betatron for use in inspecting large steam turbine, centrifugal pump and hydraulic turbine parts produced by the firm.

The new building's steel reinforced concrete walls are six feet thick and 20 ft high to shield personnel from betatron radiation. The x-ray room is large enough to accommodate a railroad car. A bridge crane capable of handling 25-tons will be used for lifting the specimens. The building also has a control room with operating panels and circuits, a darkroom with a dual set of stainless steel developing tanks, and a viewing room for inspection of radiographs.

The betatron will be mounted on a crane which will permit the beam to be rotated through 180 degrees about the horizontal axis and 360 degrees about the vertical axis of the focal spot. Castings will be placed below the unit.

Allis-Chalmers has had a 22-million volt betatron at West Allis since 1948 in a smaller building. This betatron has a fixed beam, instead of the rotatable beam. It was used in experimental and test work and radiography and can now be used exclusively for betatron development and test work.

The 22-million volt betatron can be used for effective inspection of steel sections from one inch to about 24 inches thick. For thicknesses of less than an inch, the conventional 220,000-volt x-ray machine is more efficient.

Existing industrial x-raying facilities at Allis-Chalmers include a 220,000-volt and a 400,000-volt machine. With this equipment the maximum thickness of iron or steel that can be comprehensively examined for hidden flaws is about 3½ in. These machines have not been adequate for inspection of many castings with sections more than four inches thick.

By late spring of 1953, Allis-Chalmers will have built 24 betatrons ranging in voltage from 20 to 24 million. The first two machines completed went to the University of Illinois for testing and calibrating, then were shipped to the Atomic Energy Commission and to the Rock Island Arsenal for evaluation in ordnance work. Two of the machines are in use at Los Alamos, New Mexico, for research with the atomic bomb. Six are being used at various universities for physics research.

Five betatrons have been built by Allis-Chalmers for the current defense program and three more are on order. The first machine, completed early in 1951, is in operation at Watervliet Arsenal, Watervliet, N. Y., where it is being used for inspection of muzzle brakes, gun breach mechanisms, and defects in gun barrels as large as 16 in. Two betatrons for defense went to the Continental Foundry and Machine Co., East Chicago, Ind., and Coraopolis, Pa. The other two have been installed in plants of the General Steel Castings Co., Philadelphia, Pa., and Granite City, Ill.

ALCOA UNVEILS HUGE GERMAN FORGE PRESS

▲ Aluminum Co. of America recently unveiled a 15,000 ton forge press made in Germany during World War II, and now in operation at Alcoa's Cleveland, Ohio, works.

Built early in the war, the press was constructed by the Schloemann Co. of Dusseldorf for use in Germany's wartime light alloy industry.

The giant press, leased from the United States Air Force, will make it possible for Alcoa to produce large aluminum and magnesium forgings for aircraft faster and more economically than before.

The new press is the latest and largest addition to Alcoa's hydraulic press forging facilities. The company has had other hydraulic forge presses in operation for more than a decade.

To house the giant press, Alcoa erected an aluminum-clad building equivalent in height to a five-story structure. A special overhead crane was installed to lift parts weighing up to 120 tons as the press was being reassembled. The foundation required more than 1,000 cu yd of concrete. The pouring proceeded continuously for more than 30 hours.

A huge double-headed die-sinking machine was installed to make the dies used by the press. In some instances a set of dies for the press will weigh 25 tons. A total of 30,000,000 lb of pressure is exerted on the press die table which is 21 ft long and 7½ ft wide.

With auxiliary equipment the press is valued at $6,200,000 and installed is 22 ft long, 18 ft wide and extends 18 ft below ground level and 36 ft above.

Upon arriving in the United States from Germany, the dismantled press was stored in the old bomber plant, now the Cadillac Tank Plant, at Cleveland Hopkins Airport. When that plant was reactivated and converted for production of army tanks, the press was moved to its present location and the task of reassembling the $3,000,000 puzzle from old German blueprints was begun.

The press was completely overhauled by Alcoa and refinished throughout. It is a thoroughly modern machine supported with the best of heating and handling facilities.

The new press is part of a $13,200,000 expansion program to enlarge Alcoa's 35-year-old Cleveland forge plant, already the largest aluminum forging operation in the nation.

In addition to viewing production on the 15,000 ton press and inspecting allied forging facilities, the government and air force officials toured Alcoa's Aluminum Research Laboratories. Company facilities are located at 2210 Harvard Ave.

CLEVELAND REDUCES AIR POLLUTION

▲ Air pollution poses perplexing problems, both economic and technical.

Yet, despite these difficulties, Cleveland, Ohio, has made since 1946—and continues to make—substantial progress in combating atmospheric contamination.

Such advances include: Reduction in city-wide air pollution deposits (soot, dust, cinders, and so on) from 38.2 tons per sq mi per month in 1949 to 35.6 tons in 1950.

Since 1946, when the monthly deposit per square mile was 51.5 tons, air pollution deposits have dropped 31 per cent. A 50 per cent drop was made in the number of plants emitting nuisances from industrial processes in 1950. Industrial smoke is 74 per cent less than in previous years.

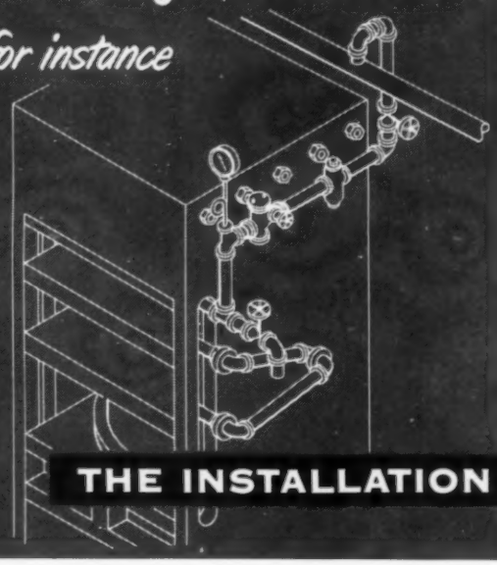
As part of a $75,000,000 program for expanding its productive capacity, Republic Steel Corp. has underway a new $20,000,000 coke oven plant.

Cleveland's other two major steel producers, Jones & Laughlin Steel Corp., and American Steel & Wire Co., likewise have made a number of improvements resulting in substantial air pollution reduction.

Will Your Pressure Regulators Last 25 Years?

...on Molding Press Service

for instance



THE INSTALLATION

Crane Brass Pressure Regulators on steam lines to rubber molding presses; Dryden Rubber Division, Sheller Mfg. Corp., Chicago. 225 units in service.

VALVE SERVICE RATINGS

FEATURES:	Equally good on steam or air
SUITABILITY:	Steady outlet pressure - No drift
MAINTENANCE COST:	Routine servicing only
SERVICE LIFE:	Many installed more than 25 years — Still O.K.
OPERATING RESULTS:	Fully automatic steam control at lowest cost
PRICE:	Good Buy - has no equal
AVAILABILITY:	Stock item in Crane Line

THE HISTORY

Steam generated at 130 psi is reduced through individual regulators on molding presses. Pressure used at machines is 60 to 100 psi depending on work. Features of regulator service needed most are: (1) non-fluctuating outlet pressure automatically maintained within close regulation; (2) easy adjustment by press operator to specified pressure for given work.

More than 25 years ago the plant standardized on Crane Regulators, a total of 225 being in use today. Many are the original installations, still delivering desired outlet pressure. Records for all regulators, regardless of age, show no maintenance cost other than prescribed simple routine servicing. On old models of the Crane 960 regulator, after prolonged service, this includes occasional regrinding of seats.

THE VALVE

Crane No. 960 Brass Pressure Regulators reduce steam or air pressures up to 250 psi, to within 80% of inlet pressure. Factory pre-set to operate within any of 4 ranges from 1 to 200 psi, with easily selected service pressure within set range. Precision made; fully automatic; highly dependable, even under reasonable fluctuation of inlet pressure. All wearing parts renewable. See your Crane Catalog or Crane Representative for full data.

The Complete Crane Line Meets All Valve Needs. That's Why—

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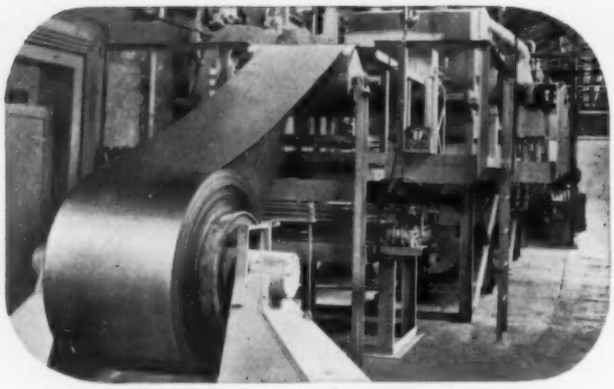
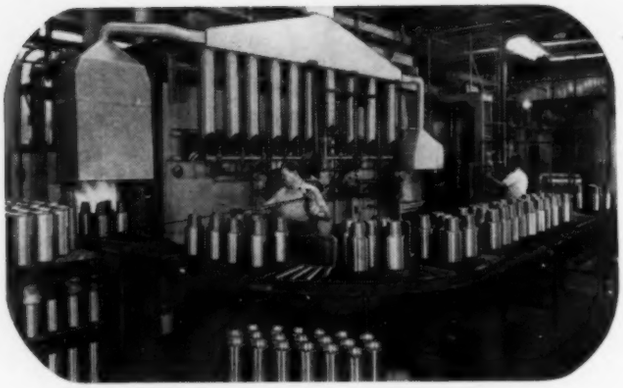
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING



EF CONTINUOUS STRIP LINES—for annealing, galvanizing, aluminizing, etc. This combination gas-fired and electric unit provides flexibility in controlled heating, soaking and cooling, for producing various surface and metallurgical conditions on ferrous and non-ferrous strip.



EF GAS CARBURIZING FURNACES. This gas-fired radiant tube installation handles several different heat treating processes and cycles—efficiently and economically. It improved product uniformity and production control—and reduced costs.

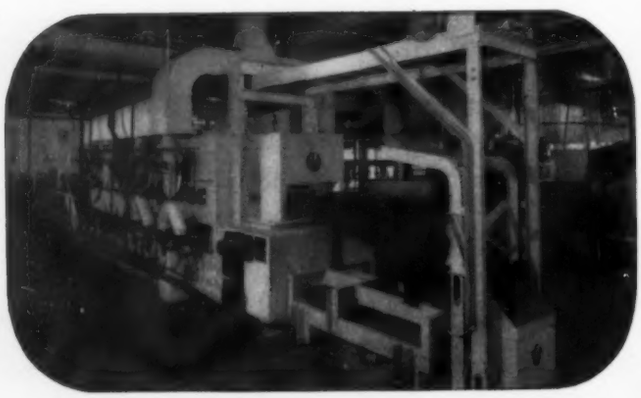
EF builds Gas-Fired, Oil-Fired and Electric Furnaces for these and other heat treating operations

- AGING
- ANNEALING
- ALUMINIZING
- BRAZING
- CARBON RESTORATION
- CARBURIZING
- CERAMIC DECORATING
- DRAWING
- GALVANIZING
- HARDENING
- HOMOGENIZING
- MALLEABLIZING
- NORMALIZING
- NITRIDING
- SINTERING
- SOLUTION TREATING
- SPECIAL ATMOSPHERE TREATMENTS AND OTHER PROCESSES

● EF engineers specialize in designing and building production furnaces — continuous and batch types — including roller hearth, roller rail, chain belt, wire belt, slot and tube conveyor types, reciprocating, rotary, car, bell, pit and other designs; complete with special atmosphere producers, and time and labor saving material handling equipment as required.

Reflecting more than 30 years of continuous research and experience, and outstanding engineering accomplishments, EF furnaces combine high heating efficiency, accurate automatically controlled cycles, and advanced designs that minimize maintenance, assure economy of operation, high hourly output and uniformity of product.

Submit your production furnace problems to ***experienced engineers — it pays.***



EF CHAIN BELT CONVEYOR FURNACES. Unsurpassed for uniform, low cost scale-free hardening, carbon restoration and non-decarb heat treating of small and medium size products — continuously. 11 sizes. Capacities 175 to 2000 lbs. per hour. 12 page bulletin available.

The Electric Furnace Co.

Salem, Ohio

EF

Gas-Fired, Oil-Fired and Electric Furnaces For any Process, Product or Production

The Keystone INTEGRATED ALUMINUM* Conductor System

LOWER COST
LIGHTER WEIGHT, HIGHER EFFICIENCY
SAFER ENCLOSURES

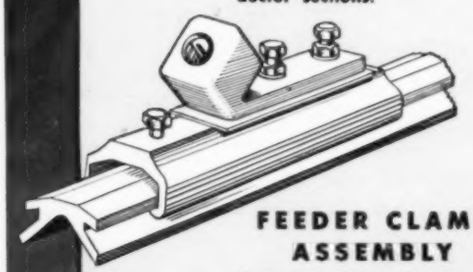
An integrated power supply system designed to complement the best materials handling equipment—1000 amperes capacity for heavy duty systems . . . economical for use on control circuits.

The Keystone Aluminum Conductor System is now being employed in outstanding installations, after having been developed through years of research in the laboratory and industry. It has been carefully designed to solve the troublesome problems formerly encountered.

The light weight of this conductor system reduces costs of installation, insulators and supporting structures. Its non-corrosive qualities permit use on sensitive control circuits. Longer contact life. Compact design saves space, permits better protection. All components are pre-fabricated. Available complete with brackets and enclosures. No copper boosters nor priorities needed. Easily engineered, installed and maintained.

HANGER SECTION
Conductor free to slide within support, allowing for expansion and contraction.

JOINT PLATE AND BOND ASSEMBLY
Non-loosening spring-type splice plate provides excellent electrical and mechanical joint characteristics between conductor sections.



FEEDER CLAMP ASSEMBLY
features a bimetal separator that eliminates galvanic corrosion between copper terminal and aluminum surface, providing foolproof, long-lasting connection.

*Domestic and Foreign Patents Pending

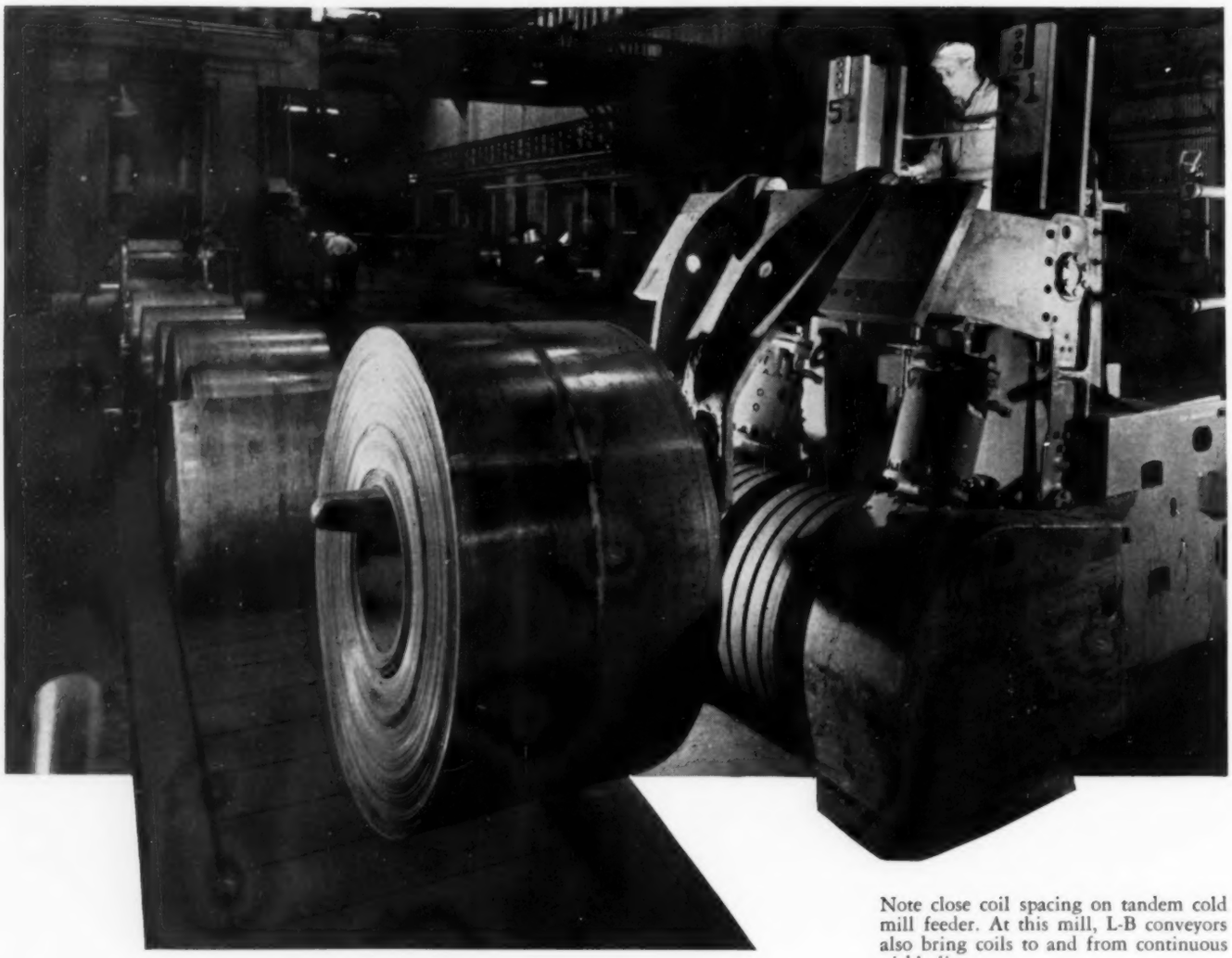
Write today for new, illustrated 4-page folder on Keystone Integrated Aluminum Conductor System.

ELECTRIC SERVICE MANUFACTURING CO.

PHILADELPHIA 32, PENNA.

YIELD GOES UP...WASTE GOES DOWN

...with LINK-BELT coil handling conveyors



Note close coil spacing on tandem cold mill feeder. At this mill, L-B conveyors also bring coils to and from continuous pickle line.

Pallet feeders keep huge cold reduction mills rolling at high speed

There's no waiting for cranes or trucks when rolling mills are served by Link-Belt feeder-conveyors. That means the rated capacity of a mill can be fully realized.

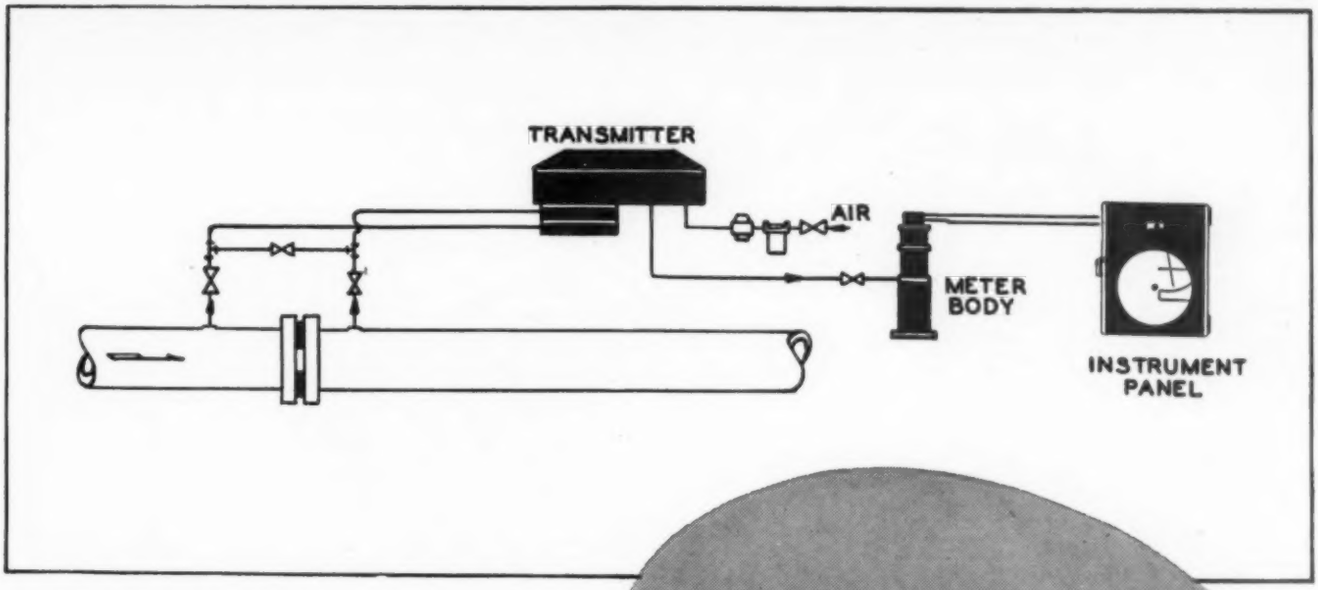
Equally important, the gentle handling assures less scrap loss. Even on coils weighing as much as 75,000 pounds, there's no telescoping . . . no peening of edges.

Link-Belt builds three different basic designs of coil handling conveyors to meet widely varying physical and economic requirements. Our engineers will work with your own engineers, consultants and builders of mill and process equipment — help you select the right system for your exact needs.

LINK-BELT

MATERIALS HANDLING, PROCESSING and POWER TRANSMISSION MACHINERY

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Cleveland 15, Pittsburgh 13, Toronto 8, Springs (South Africa). Offices in principal cities. 12,567



Republic Pneumatic Electric Metering System

DESIGNED ESPECIALLY for YOU Mr. Steelmaker

to Measure Blast Furnace and Coke Oven Gas Flow

We had your problems in mind when we designed the Pneumatic Electric Flow Meter. We know a steel mill is a dusty place; it can't be otherwise and do a good job making steel. We know the gases produced in a steel mill are dirty. So, to help you steel mill people keep track of what is going on inside your maze of pipes, furnaces and ovens, we designed a meter that could operate in dusty surroundings and accurately measure flow of dirty gases without frequent maintenance. Yes, we engineered the dirt right out of the meter.

Here's How:

KEEPS DIRT OUT

The Pneumatic Electric Flow Meter uses a differential pressure transmitter to isolate dirty gases from direct contact with mercury in meter body. Transmitter establishes an air loading pressure that is directly proportional to flow differential. The measuring chamber of the transmitter is small and has practically no change in volume when differential pressure changes. Thus, dirt in the gas is not sucked into the chamber to cause the diaphragm to stick or clog.

DOUBLY DUST SEALED

Rugged boiler meter case completely encloses reading instruments which are individually sealed. Double seal prevents dirt from getting in to foul or clog parts and cause inaccuracies or failure.

REMOTE READING INSTRUMENTS

Meter body responds to air loading pressure changes from transmitter and produces proportional electrical variations which are transferred to remote reading instruments. Integrator and recorder operate independently — may be separated to suit individual requirements.

OVER-ALL ACCURACY

Differential pressure transmitter is extremely sensitive to pressure changes, however rapid. Mercury in meter body has no work to do, only makes or breaks contact with resistance rods. Recorder permanently records rate of flow and time of flow changes. Integrator working on modified watt-hour principle *continuously* totalizes all flow, not just average of spot readings. Accurately follows all sudden changes in flow.

RANGE EASILY CHANGED

Differential pressure transmitter and meter body can be adjusted (many times right in the field) for almost any range.

CONTINUOUS METERING

Measurement and control of fluid flow is not interrupted by meter failure because Pneumatic Electric Flow Meter is built to give dependable, maintenance-free service. Working mechanism is accessible and easy to adjust. And remember—Republic has 28 branch offices throughout the country, so there's one near you to help you with your metering and control service problems.

Pneumatic Electric Flow Meter is also excellent for metering widely varying flows such as occur in oxygen scarfing operations.

REPUBLIC FLOW METERS CO.

2240 Diversey Parkway, Chicago 47, Illinois

PROGRESS REPORTS FAVOR EXTENDED USE OF NATIONAL CARBON IN BLAST FURNACES

TRADE-MARK

The term "National" is a registered trade-mark of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

In Canada: National Carbon Limited, Montreal, Toronto, Winnipeg

● The future of "National" carbon as a preferred material for blast furnace linings is definitely assured by the mounting evidence of its extra long life in hearths and, more recently, in side walls all the way up to the mantle.

Already, indications are that, as carbon goes *up* the furnace, operating costs come *down*. Fewer shut-downs, more uniform casts are consistently being obtained in existing installations. And increased capacity can be expected to result from the use of thinner wall sections, made possible by this ideal furnace-lining material.

Furnace operators are urged to keep their eyes on carbon and on the growing body of data covering its use in modern, high-tonnage-life furnaces.

WHY BUY THIS ITEM?

It gives you *double the usable light!*
No metal can to *leak or corrode!*
It can't *stick, swell or jam!*
It delivers the *whitest, brightest light!*

It's the "Eveready" No. 1050 flashlight battery, made with the zinc electrode inside a carbon jacket — just the reverse of every other battery on the market.

Test it and . . . you always buy it!

OTHER NATIONAL CARBON PRODUCTS

BLAST FURNACE LININGS • BRICK • CINDER NOTCH LINERS • CINDER NOTCH PLUGS • SKIMMER BLOCKS • SPLASH PLATES • RUNOUT TROUGH LINERS • MOLD PLUGS • TANK HEATERS

Personnel News...

T. M. Fairchild has been named assistant to general manager, Bethlehem Steel Co., Johnstown, Pa. James G. Smith, formerly assistant superintendent of mills at Bethlehem's Lackawanna, N. Y. plant, succeeds Mr. Fairchild as superintendent of Franklin Mills at Johnstown plant.

Edward J. Duffy, general superintendent at Kaiser Steel Corp., Fontana, Calif., was appointed assistant to the works manager, in charge of iron ore and coal production at company-owned mines at Eagle Mountain, Calif., and Sunnyside, Utah. **Barney Dagan** was named general superintendent of Kaiser Steel, succeeding Mr. Duffy. As general superintendent, Mr. Dagan will be in charge of general mill operation and the plant expansion for a third blast furnace, a ninth open hearth, and other facilities announced under the recent 65 million dollar expansion program.

K. M. Patterson has been appointed manager of the headquarters industrial department of the apparatus division, Westinghouse Electric Corp., East Pittsburgh, Pa. Prior to this appointment, Mr. Patterson was manager of the department's steel mill and metal-working section.

A native of Harrisonburg, Va., Mr. Patterson was graduated from Georgia Institute of Technology and joined the company's graduate student training course in 1923. Since that time he has been engaged in sales activities in connection with large motor apparatus. At one time he served as special representative in the transportation and generator division. **M. E. Knudson** has been named manager, steel mill and metal working section, industrial department to succeed Mr. Patterson. Mr. Knudson graduated from the University of Minnesota with a bachelor's degree in electrical engineering and joined the Westinghouse graduate student course in 1930. Previous to this appointment, Mr. Knudson was an application engineer in the Chicago, Ill., office.

Richard L. Bowron was named assistant to the vice president in charge of operations for Tennessee Coal, Iron and Railroad division of U. S. Steel Corp., Ensley, Ala.

W. H. Lagerstrom has been appointed general manager of Damascus Tube Co., Greenville, Pa. Mr. Lagerstrom was formerly operating superintendent and construction engineer for National Tube division of U. S. Steel Co. He has been associated with the pipe and tube industry for 39 years.

G. W. Kelly, purchasing agent of Kaiser Steel Corp., Oakland, Calif., has been named general purchasing agent. Mr. Kelly will be in full charge of all purchasing activities for the company's mines, mills and offices, and will continue to maintain offices in Oakland. **R. L. Lamborn,** presently scrap procurement manager at Los Angeles, is being transferred to the home office in Oakland as purchasing agent, reporting to Mr. Kelly. **W. F. Bowles,** formerly scrap buyer at Los Angeles, has been appointed assistant purchasing agent at Oakland, and **H. R. Bohme,** formerly Mr. Kelly's assistant, is being made assistant to the purchasing agent at the Kaiser Steel mill, Fontana, Calif.

Timothy J. Harrison, formerly assistant chief combustion engineer for Republic Steel Corp. in Chicago, Ill., is now combustion engineer for Continental Steel Corp., Kokomo, Ind.

Bartlett Richards, assistant to the vice president in charge of production, was elected to the board of directors of Acme Steel Co., Chicago, Ill., to replace Ralph H. Norton, who resigned. Mr. Norton, who retired from the company in 1948, served on the board for 46 years. Joining the company in 1904, he was elected as a director the following year, rising to become president in 1923 and board chairman in 1941. In a letter to present company officials, Mr. Norton requested that his place on the board be filled by someone more actively associated with the business.

T. E. Hauser has been appointed general works auditor of the National Tube division, United States Steel Co., with offices at 525 William Penn Place, Pittsburgh, Pa. Since April 1950, Mr. Hauser has been works auditor for National Tube at Lorain, Ohio, and prior to that he held the same position at the com-

T. M. FAIRCHILD

EDWARD J. DUFFY

BARNEY DAGAN

K. M. PATTERSON

pany's National Works at McKeesport, Pa., for five years.

W. Cordes Snyder, Jr., president and chief executive officer of the Blaw-Knox Co., Pittsburgh, Pa., has been elected to the additional post of chairman of the board of directors.

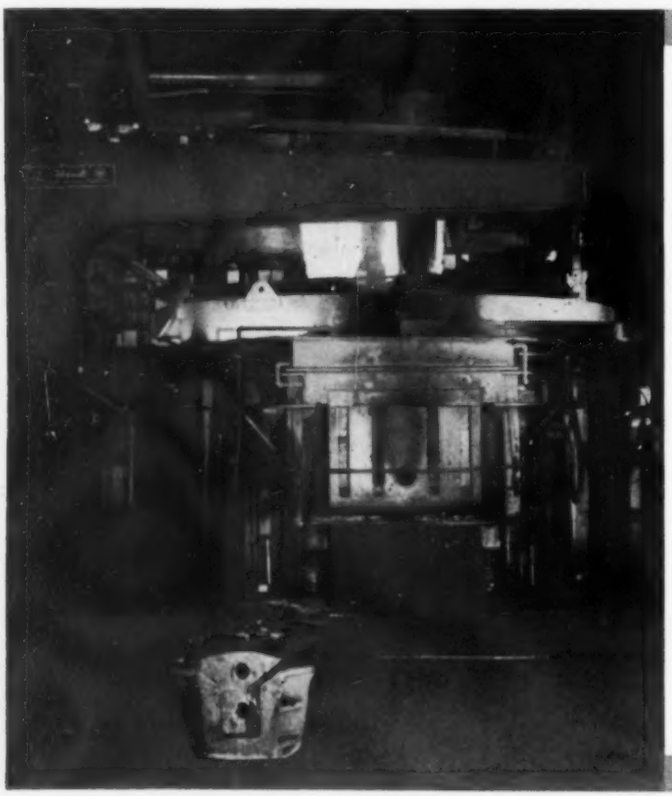
W. CORDES SNYDER, JR.

W. S. Schamel, formerly sales engineer, has been advanced to assistant technical director of the dust and fume division, American Wheelabrator and Equipment Corp., Mishawaka, Ind. **G. W. Roper, J. K. Davidson** and **F. A. Lindahl** have been named project engineers.

Dr. Gilbert E. Doan will join the research department of Koppers Co., Inc. on August 1. Dr. Doan, who has been head of Lehigh University's Department of Metallurgy since 1939 will become manager of the metallurgical branch of the research department of Koppers Co., Inc. on August 1.

DR. GILBERT E. DOAN

C. Duff Brown has been appointed works manager of Duff-Norton Manufacturing Co., Pittsburgh, Pa. Mr. Brown will supervise plant operations for the company's jack division. Mr. Brown was formerly superintendent of engineering for McKinney Manufacturing Co.



Heroult

ELECTRIC MELTING FURNACE

. . . as ever, the dependable furnace for the production of high-grade stainless, alloy and rimming steels.

Removable roof of new design now available for the larger furnaces.

AMERICAN BRIDGE DIVISION
UNITED STATES STEEL COMPANY

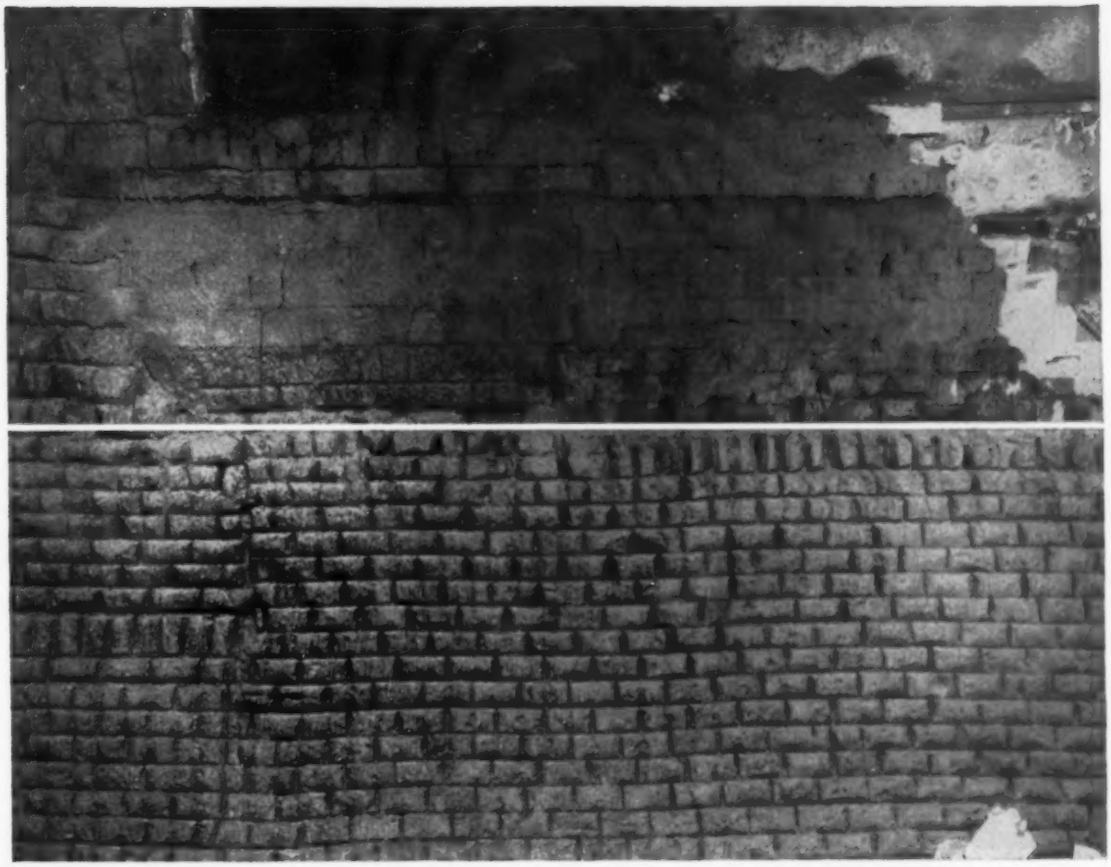
General Offices: 525 William Penn Place, Pittsburgh, Pa.
Contracting Offices in New York, Philadelphia, Chicago, San Francisco and other principal cities

AMERICAN BRIDGE

USS

UNITED STATES STEEL

MIGHTY FINE FOR MIXERS



Area below white line is TASIL brick and cement in front-wall of 1300 ton mixer after handling 827,000 tons during 18-month period. High duty fireclay brick in less vulnerable area above white line, show severe erosion.

TASIL LASTS TWO CAMPAIGNS

Taylor Sillimanite (TASIL) Brick, laid in TASIL No. 302 Heat-Setting Cement, were used to "*balance*" the refractory lining of a 1300-ton Hot Metal Mixer which began operation in June, 1950. TASIL was used to strengthen the vulnerable areas of the front-wall, backwall and endwalls, and the pour-out spout jambs, sidewalls and bottom.

When this mixer came down in April, 1951, after approx. 450,000 tons had been through it, the TASIL Brick in the front and backwall were in such excellent condition they were *left in for the second campaign*. The TASIL in these areas had lost only 2 to 2½".

The second campaign ran from April to December, 1951, handling approx. 377,000 tons. Total for the two campaigns on the TASIL front and backwall are impressive:

MONTHS SERVICE: 18
TONNAGE HANDLED: 827,000 (approx.)

A five-campaign average for Blast Furnace Quality Firebrick linings in this mixer was 225,000 tons.

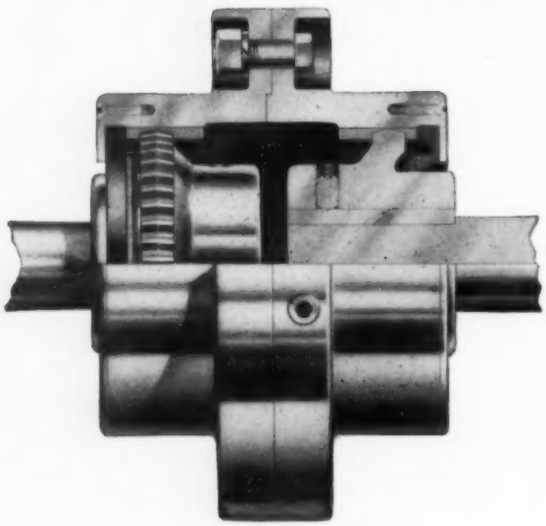
Results such as this continue to prove that TASIL "Balanced" linings are unsurpassed, from the standpoint of *over-all life and economy*. Use TASIL Brick in the areas of severe erosion—Fireclay Brick in the remainder of the lining—*all* laid in TASIL Cement. Call in a Taylor representative for a factual discussion of the TASIL possibilities in your plant.

Exclusive Agents in Canada:
REFRACTORIES ENGINEERING AND SUPPLIES, LTD.
Hamilton and Montreal

The CHAS. TAYLOR SONS Co.
A SUBSIDIARY OF NATIONAL LEAD COMPANY
REFRACTORIES SINCE 1864 • CINCINNATI • OHIO • U.S.A.

AJAX DIHEDRAL

New Coupling
STEEL MEN
Have Waited For



▶ Ability of Ajax Dihedral Couplings to handle extreme misalignment is the talk of hard-boiled steel men everywhere.

Exclusive Dihedral tooth shape provides for misalignment up to 4 degrees as stock off-the-shelf couplings. 6, 8, 10 and 12 degree teeth cut to order.

Save costly hours of setup, change-over and maintenance time. Line up motors in minutes not hours.

Write for facts on this radically new and exclusive coupling.

AJAX FLEXIBLE
COUPLING CO. INC.
WESTFIELD, NEW YORK

F. C. Boyce has been re-elected president of the D. J. Murray Manufacturing Co., of Wausau, Wisc., for the 20th consecutive time. Other officers re-elected are: **M. P. McCullough** and **D. C. Everest** as vice presidents; **A. W. Plier,** executive vice president and general manager; **G. L. Ruder,** treasurer; **W. A. Marquardt,** secretary; and **C. L. Durkee,** vice president and sales manager.

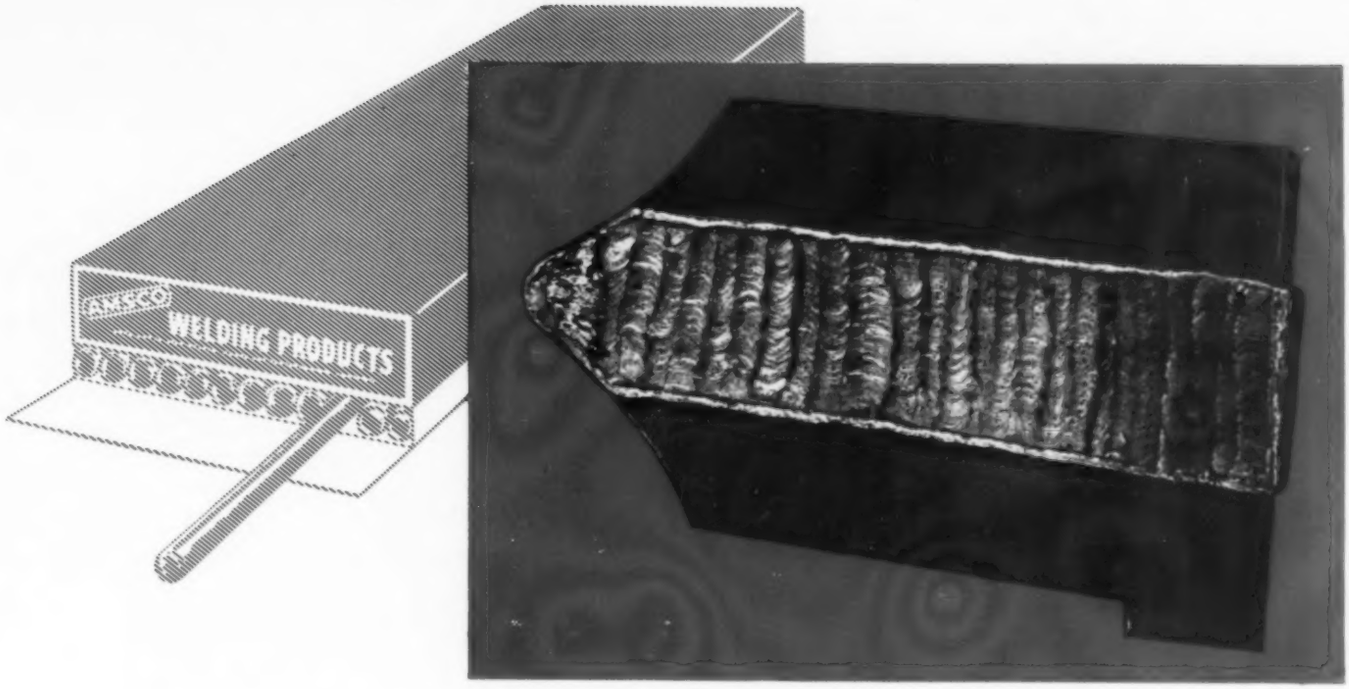
John E. Carroll has been elected to the board of directors of American Hoist and Derrick Co., St. Paul, Minn. Mr. Carroll is vice president of sales of the company.

William L. Hartley, formerly sales manager at Link-Belt Co.'s Philadelphia, Pa., plant, has been transferred to executive sales headquarters at Chicago. Ill., to specialize in the application of long-haulage belt conveyors and to assist on other major engineering projects.

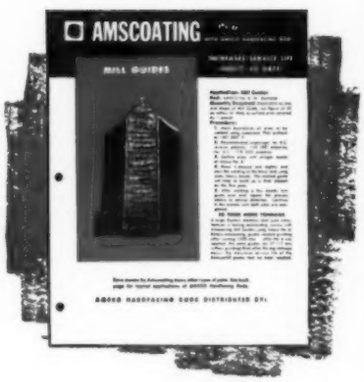
George W. Brown was named as executive engineer for Wagner Electric Corp., St. Louis, Mo.

GEORGE W. BROWN

Dr. Paul D. Merica, executive vice president and a director, was elected president of International Nickel Co., of Canada, Ltd. **Dr. John F. Thompson,** who was elected chairman of the board of directors in February, 1951, upon the death of **Robert C. Stanley,** continues as chairman and chief officer of the company. **R. Leslie Beattie,** vice president and general manager of the company's Canadian operations, who is moving his headquarters from Copper Cliff, Ont., to Toronto, has been elected a member of the executive committee of the board and a director of the company's United States subsidiary, International Nickel Co., Inc. **H. C. F. Mockridge,** of Toronto, was also elected to the executive committee of the board. With Mr. Beattie's move from Copper Cliff, **J. R. Gordon,** assistant vice president, has been appointed to the further post of assistant general manager, and in these capacities will manage all activities in the Canadian operations under the direction of Mr. Beattie. **Ralph D. Parker,** assistant vice president, has been elected vice president and a director of the company's subsidiary, Canadian Nickel Co., Ltd., which conducts the company's vital exploration and prospecting program throughout the world. **William F. Kennedy** has been named secretary of the company, succeeding **Henry S. Wingate,** who



How to run more tonnage — with fewer shutdowns



How to Amscoat Mill Guides . . .

This procedure sheet gives complete details . . . the AMSCO electrode to use and method of application. Also lists electrode recommendations for other iron and steel applications. Free copy on request.

An example of how AMSCOATING with Amsco Hardfacing Electrodes can save materials, manpower and money.

A large Eastern seamless steel pipe manufacturer can quote—from the record—on the big savings possible through Amscoating!

Before Amscoating, Mill Guides had to be removed and reground after running an average of 1200 tons. After Amscoating with an Amsco electrode specially developed to stand up under heat and abrasion, the same guides ran 37,117 tons without grinding—*over 30 times longer*—and were still in good condition for further service!

Amscoating can reduce shutdowns, repairs and replacements, as demonstrated by this actual case history. The inevitable result is that production goes *up* . . . and maintenance costs *down.* Write today for catalog on dollar-saving Amsco Electrodes and name of your nearest Amsco Distributor.

AMSCOATING
THE RIGHT WAY TO SAY HARDFACING

AMERICAN Brake Shoe COMPANY

AMERICAN MANGANESE STEEL DIVISION
411 EAST 14th STREET • CHICAGO HEIGHTS, ILL.

Other Plants: New Castle, Del., Denver, Oakland, Cal., Los Angeles, St. Louis. In Canada: Joliette Steel Division, Joliette, Que.
Amsco Welding Products distributed in Canada by Canadian Liquid Air Co., Ltd.

Filling your complete needs for Steel Mill Space Conditioning—

1 CRANE CAB CONDITIONERS

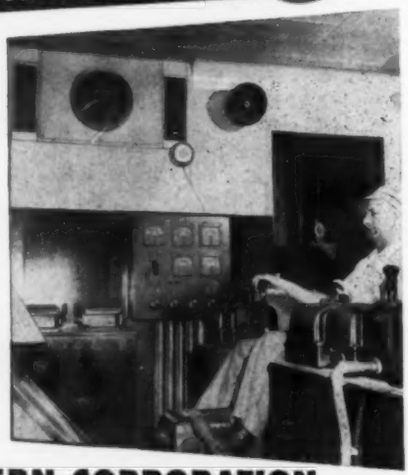
• The condenser is located at any convenient place on crane, and evaporator (cooling coil) is placed in cab. The two units are connected with refrigerant lines properly secured and protected against breakage. Condensers are air-cooled, assuring trouble-free service with but little maintenance.

2 VENTILATING HEATER FOR GENERAL PURPOSE CRANES

Available with filter unit for crane cabs and isolated spaces, this 49-VHG cab unit serves the year around, furnishing ventilation and air movement throughout the cab. Compact, efficient, inexpensive.

3 PULPITS OPERATING STANDS and CONTROL ROOMS

The line of Aire-Rectifiers is complete for all types of mill pulpits — for those of the most modern design to existing pulpits where costs must be kept down. Many are interchangeable with crane cab Aire-Rectifiers, thereby keeping service parts stocks at a minimum.



THE LINTERN CORPORATION

P. O. BOX 428 • PAINESVILLE, OHIO

will devote his full time as vice president and a director of the company.

John D. Hinton was appointed assistant manager of equipment sales and **Richard L. Berry** manager of laminated plastic sales for American Brakeblok Division of American Brake Shoe Co. Mr. Hinton was formerly sales representative in Portland, Ore. and Mr. Berry was a sales engineer in the Chicago, Ill., area. Both men will be located at the division headquarters in Detroit, Mich.

F. H. Allison, Jr. has been appointed assistant vice president of Blaw-Knox Co., Pittsburgh, Pa., in charge of metallurgy and roll sales. Dr. Allison will be directly responsible for integrating the sales and servicing functions of the two Blaw-Knox roll organizations — Pittsburgh Rolls and Lewis Rolls. He will also have full responsibility for the metallurgy in the company's Pittsburgh foundries. Dr. Allison comes to Blaw-Knox from United Engineering and Foundry Co., where he

F. H. ALLISON, JR.

has been employed since 1934 and for the past eight years has been chief metallurgist. From 1926 to 1934 he was with Crucible Steel Co. of America, where he was assistant to the chief metallurgist and active in research. Earlier in his career, he spent one year with Westinghouse Electric Corp. in research work.

James R. Weaver has been appointed assistant to the vice president in charge of manufacturing for Westinghouse Electric Corp., Pittsburgh, Pa. For the past four years, Mr. Weaver has been on assignment to Baldwin-Lima-Hamilton Corp. where he served as vice president in charge of manufacturing. In his present position, he will be located in Pittsburgh.

Richard A. Gehr has been named sales manager of heaters and devices for the General Electric Co.'s industrial heating department, in Schenectady, N. Y. Mr. Gehr, previously New York district heating specialist for the company, succeeds **Robert W. Kise,** of Schenectady, who was recently appointed manager of product planning for the industrial heating department.

George W. Edwards has been named service manager of the special service division, of Basic Refractories, Inc. Mr. Edwards has been with Basic since 1947, serving in sales capacities. Prior to his joining Basic, he spent fourteen years with Republic Steel Corp., his last position being that of melter. **Charles R. Heilig** has

HAGAN Compensated Ring Balance Meters

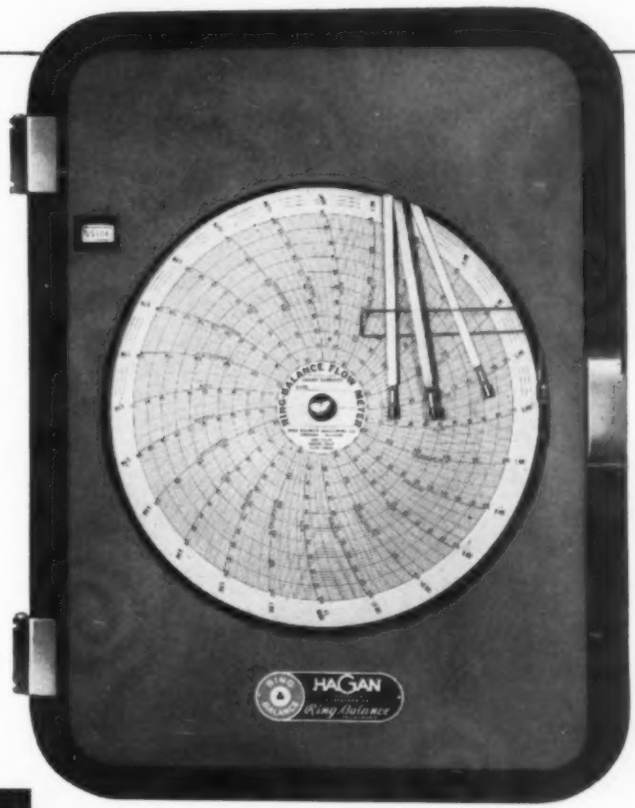
provide *accurate, automatic* compensation

- for *temperature*
- for *pressure* or
- for *pressure and temperature*

When you measure flow of liquids or gases, and pressure and temperature variations occur, there are two ways to correct meter readings — one by expensive and laborious clerical calculations, the other, by using the Hagan Compensated Ring Balance Meter in the first place. This Hagan Compensated Meter corrects *automatically* for variations in pressure, temperature, or pressure and temperature, and makes a chart record of both the corrected and the uncorrected flow. The built-in integrator totalizes the corrected flow automatically.

Dependable Hagan Ring Balance Meters are simple, ruggedly built, and designed for years of trouble-free service. Some features of Hagan Ring Balance Meters include:

- **Mercury level not critical**
- **Ease of dead-weight calibration**
- **No stuffing boxes or pressure-tight bearings**
- **High sensitivity at low flow rates**
- **Adjustable, full-scale range**



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Standard brushes have been solving commutation problems for a quarter of a century on applications small and large. We have the research and engineering facilities necessary for the proper evaluation of your specific need.

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BRUSHES for Rotary Converters • Synchronous Motors • Mill and Crane Motors • Mining Machinery Motors • Large Rolling Mill Equipment • Plating Generators • Everything in the fractional line.

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been named senior sales engineer of Basic's central district. He will represent Basic to major metal producing areas in Ohio, Pennsylvania, Kentucky and West Virginia. Mr. Heilig joined Basic in 1944. He had 25 years experience in steel production as chemist, melter, furnace operator and open-hearth superintendent.

Ransom Cooper, Jr. has been appointed manager of the nickel sales department and **H. D. Tietz,** manager of the nickel alloys department of International Nickel Co., Inc., New York, N. Y.

James H. Elkus has been appointed assistant manager of the Blaw-Knox division of Blaw-Knox Co. In

JAMES H. ELKUS

this new post, Mr. Elkus will have responsibility, under the division manager, for all departments of this large fabricating unit at Blawnox, Pa., including sales and

W. J. KALMEYER

engineering. **W. J. Kalmeyer** was named works manager of Blaw-Knox division. In this capacity, Mr. Kalmeyer will be in immediate charge of all plant operations, plant purchasing, maintenance, and production control.

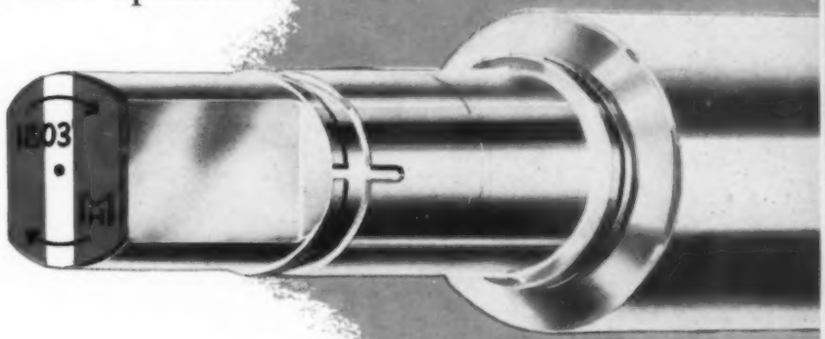
B. E. McArthur, formerly chief engineer of Magnethermic Corp., Youngstown, Ohio, has been appointed vice president in charge of engineering. **John E. Silvasy** received the appointment of chief mechanical engineer. **J. A. Hartman, Jr.,** moves to the post of sales engineer.

Torbett Crocker, formerly of Lobdell United Co. of Wilmington, Dela., has joined the staff of the Rees

to modern hot strip rolling...

MACK-HEMP ROLLS *with the striped red wabblers* do a consistent job for the skilled hot strip mill operators who use them, because Mack-Hemp's engineers coordinate their roll research and development program with the demands of the mill operators.

As a result of this progressive policy, Mack-Hemp rolls *with the striped red wabblers* give a plus value to mill operations.



Because Mack-Hemp is always working to make each roll better than the one before—because Mack-Hemp keeps up with the latest developments in rolling mill practice, it's a good idea to keep your eye on what's new and different at Mack-Hemp.

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Makers of the Rolls with the Striped Red Wabblers
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MACKINTOSH-HEMPHILL PRODUCTS INCLUDE: rolls . . . steel and special alloy castings . . . completely integrated strip mills . . . heavy duty engine lathes . . . Mackintosh-Hemphill rotary straighteners . . . improved Johnston patented corrugated cinder pots and slag-handling equipment . . . shape straighteners . . . end-thrust bearings . . . shears . . . levellers

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"Some good things to know about Metal Cleaning"

answers many questions that mean better production, more profit for you. Just look at the table of contents:

- Tank cleaning methods
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- Electrocleaning steel
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- Pickling, deoxidizing, bright dipping
- Pre-paint treatment in machines, in tanks and by hand
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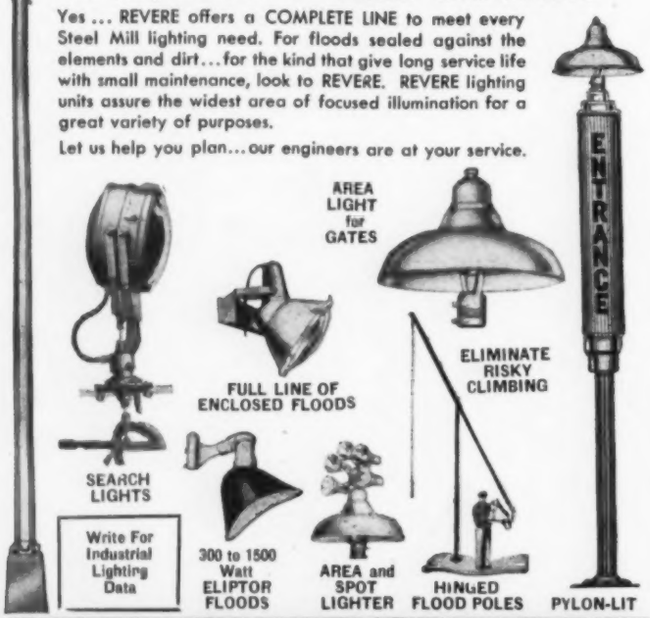
Yes ... REVERE offers a COMPLETE LINE to meet every Steel Mill lighting need. For floods sealed against the elements and dirt...for the kind that give long service life with small maintenance, look to REVERE. REVERE lighting units assure the widest area of focused illumination for a great variety of purposes.

Let us help you plan...our engineers are at your service.



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INDOOR & OUTDOOR LIGHTING FOR EVERY NEED

Machinery Co., 1012 Empire Building, Pittsburgh 22, Pa., machine tool and metalworking distributors.

Robert Oehler has been appointed Chicago district sales engineering manager for Anker-Holth, division of Wellman Engineering Co. His office will be located at 520 North Michigan Avenue, Chicago, Ill.

Thomas D. Cartledge has been elected president of Linde Air Products Co., a division of Union Carbide and Carbon Corp., New York, N. Y. Mr. Cartledge has been senior vice president of Linde Air Products Co., and a director and vice president of Dominion Oxygen Co., Ltd., a Union Carbide subsidiary.

THOMAS D. CARTLEDGE

R. W. Owens was elected to the office of senior vice president of Elliott Co., Jeannette, Pa. Mr. Owens joined

R. W. OWENS

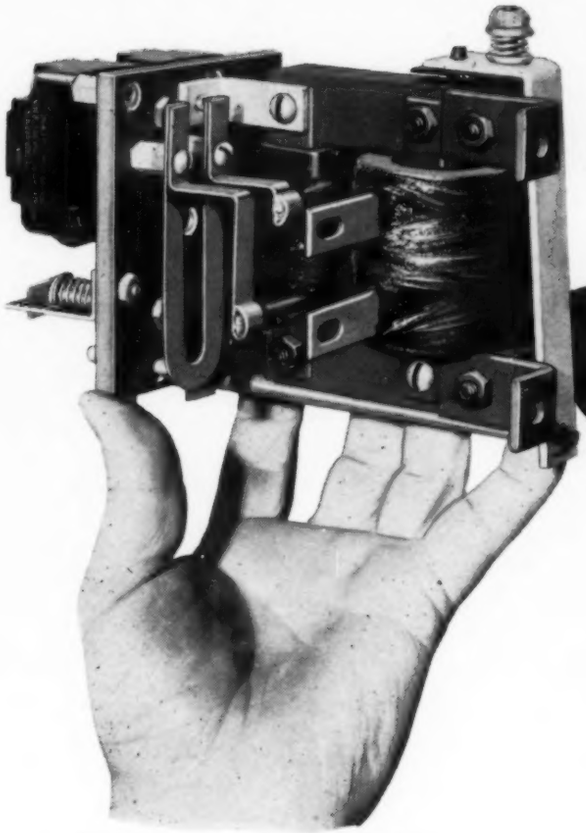
Elliott in 1944 as assistant to the president. Late in the same year he was elected vice president in charge of manufacturing, which position he held until his new appointment last month.

Paul E. Shroads has been appointed a vice president of National Steel Corp., Pittsburgh, Pa. Affiliated with National since 1930, Mr. Shroads is controller and assistant treasurer of the corporation and will continue to serve in those capacities.

Arthur M. Over was named as director of purchases for Rust Engineering Co., Pittsburgh, Pa., a new position created to coordinate the company's purchasing.

NEW EC&M *Thermal-Magnetic* OVERLOAD RELAYS

COMPLETELY PROTECT A-C *MOTORS* UNDER *all* CONDITIONS



Above—relays are front-connected and may be removed as a unit from the mounting base. U-shaped bimetal acts directly on tripping lever.

DIRECT-ACTING—NO DASHPOTS

Instantaneous Trip (magnetically)

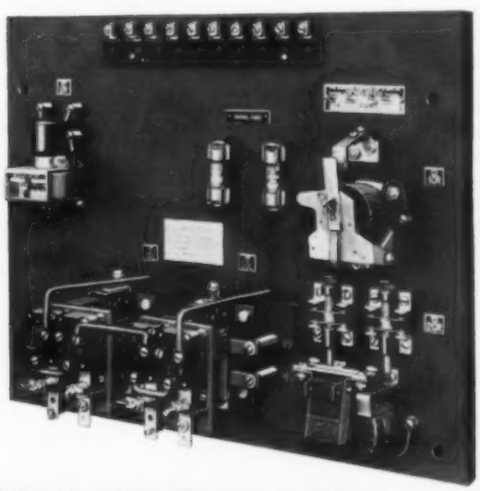
Timed Responsive Trip (thermally) on Single Phase, Failure to Start, during Running, etc.— *all* in this *one* relay

ADVANTAGES

1. Inverse time-delay operation on overloads.
2. Instantaneous operation on short circuits.
3. Short thermal reset time.
4. Saturable core aids thermal inverse time element operating characteristics.
5. Transformer couples motor current to thermal action, resulting in accurate transmission of motor operating current for quick, positive response.
6. V-split laminated core, mechanically and magnetically locked, permits changing primary coils easily.
7. Primary coils have wider current ranges than comparable heater-type relays, resulting in fewer coils for wide range of motor sizes.

No. 20 H-50 Type ZHS Starter in Type VIII Enclosure.

These Thermal-Magnetic Relays eliminate useless tripping on harmless temporary overloads. They provide positive, *timed response* to the thermal energy of load currents, and protect the motor from overheating.



Type ZTM Overload Relay Panel with Time-Delay Under-Voltage Protection Feature.

Write for NEW Bulletin 1180-37 describing these new relays.

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for GOOD MACHINE PERFORMANCE—
"Industrial Gears"
Specialization counts most when it does most good. We here at Industrial Gear, can't help but make good Gears or Sprockets because that is all we do! We have no side lines! We cut Gears, Racks, Sprockets and Splining almost around the clock.
They're cut good—they're dependable—they function perfectly in your machines and equipment.
Call on us for big 61-inch Herringbones—down to the smallest Spur. You'll like "Industrial Gear" Service.
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CHICAGO 24, ILL.

A. M. Duncan continues as purchasing agent. Mr. Over was formerly an assistant project manager.

William L. Wearly was elected to the post of general sales vice president in charge of all domestic sales, including Canada and Mexico, for Joy Manufacturing Co., Pittsburgh, Pa. Mr. Wearly joined the engineering department of Joy Manufacturing in 1937 and has served successfully as service manager and vice president, coal machinery sales.

Walter S. Tower, retiring president of American Iron and Steel Institute, New York, N. Y., was awarded the Gary Memorial Medal at the dinner meeting of the Institute, on May 22. This medal, for outstanding achievement in the industry, has previously been awarded to only ten men since it was established in 1927. It is in honor of Elbert H. Gary, founder and first president of the Institute. The citation to Mr. Tower in connection with the medal, presented by Eugene G. Grace, chairman of the Bethlehem Steel Corp., reads as follows:

"His devotion to the interests of the iron and steel industry of the United States, and his able leadership and wise counsel in guiding the affairs of American Iron and Steel Institute and strengthening its services to the industry." Mr. Tower was president of the Institute for 12 years and executive secretary for nearly seven years previously.

John W. Deimler has joined Towle and Son Co., Philadelphia, Pa., as sales engineer for Tool Steel Gear and Pinion Co. Mr. Deimler was formerly superintendent of electrical shops, Fairless works, U. S. Steel Co., Morrisville, Pa.

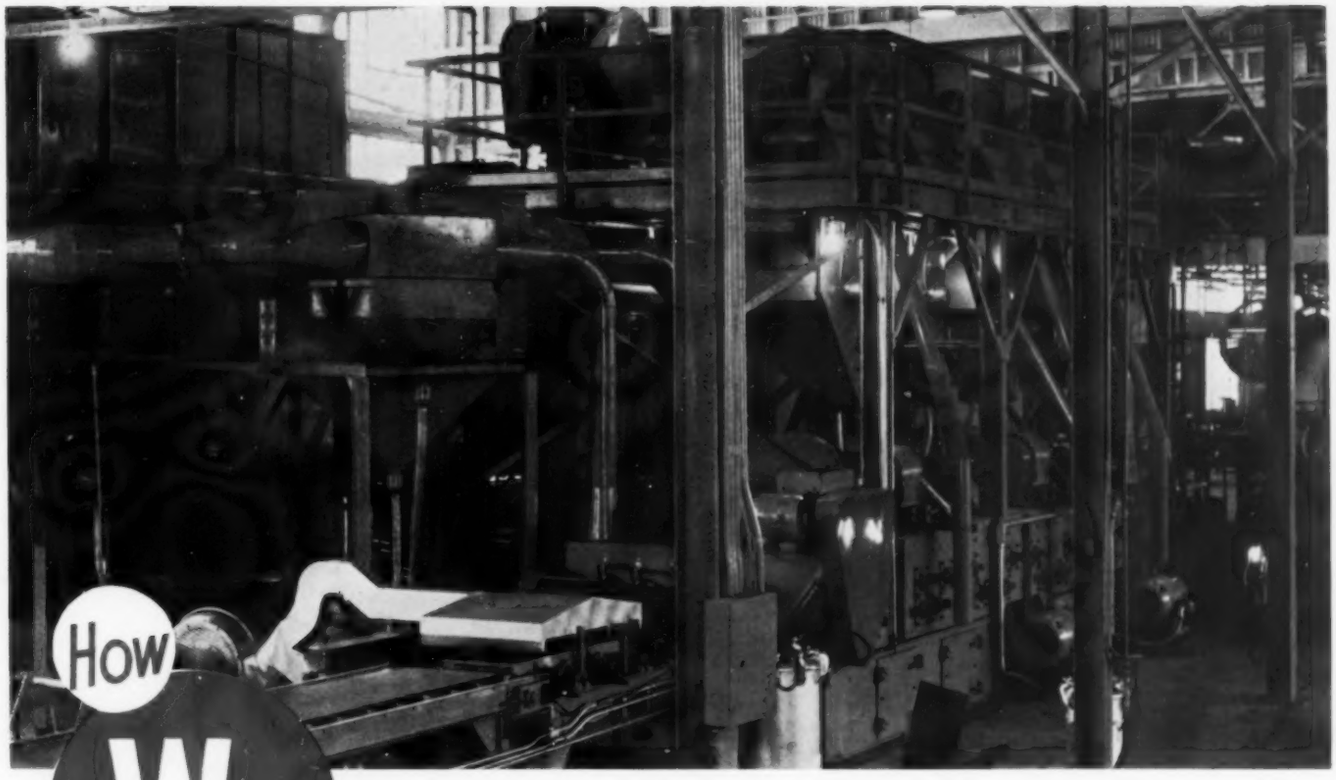
Edwin E. Davis was named manager of the order division for Jones & Laughlin Steel Corp., Pittsburgh, Pa. Mr. Davis was formerly assistant manager of the order division and succeeds **W. H. Lewis** who has been appointed director of organization planning.

Walter W. Edens has joined the sales engineering staff of Federated Metals division, American Smelting and Refining Co., New York, N. Y. Before going to Federated, Mr. Edens worked in an executive capacity with the Heil Co., and with Ampco Metal, Inc., as chief metallurgist and foundry superintendent. He has been vice president of the Badger Brass & Aluminum Foundry Co. in Milwaukee, Wisc.

Howard S. Bunn has been appointed president of Bakelite Co., a division of Union Carbide and Carbon Corp., New York, N. Y. Mr. Bunn has been vice president of Bakelite and Carbide and Carbon Chemicals Co., both divisions of Union Carbide.

Lester J. Andregg was named manager of operations of Dumas Steel Corp., Pittsburgh, Pa. Mr. Andregg started with the Otis Steel Co., later absorbed by Jones and Laughlin Steel Corp., working in various departments. He was in charge of the finishing department at the Pittsburgh, Pa., works, sheet and strip mill. Mr. Andregg has also been with the Porcelain Metal Products Co., Terminal Products Co., and more recently with Hofmann Industries as plant superintendent.

F. D. Weatherholt was named sales manager of industrial products, Westinghouse Electric Corp., East



How WHEELABRATOR® MECHANICAL CLEANING of Hot Rolled Steel Sheets Reduces Cleaning Costs per Ton

Operating results of airless Wheelabrator mechanical cleaning equipment for removing scale from hot rolled steel sheets have proved that other methods do not equal its cost-cutting performance and high speed cleaning efficiency.

In each of the seven drum plants of Rheem Manufacturing Co., for example, Wheelabrator machines have greatly reduced the cost of cleaning 18-gauge steel sheets used in the manufacture of their new Rheemcote lithographed steel drums. In other steel processing plants and steel mills, the Wheelabrator is also effecting impressive results in low cost, high production and providing extra benefits in improved surface cleanliness and better working conditions.

These production economies are a result of perfected equipment design coupled with the controlled abrasive blast of the Wheelabrator unit. With the introduction of Tru-Steel Shot, equipment operating and maintenance costs are extremely low and continuous, high-production mechanical cleaning of hot rolled products is now in actual practice.

We would be glad to demonstrate the savings the Wheelabrator can make for you. Write today for full details and an appointment to see the Wheelabrator in operation.

WHEELABRATOR — The perfected airless centrifugal blast unit pioneered by American scours away scale and dirt mechanically at low cost. Provides a more uniform etch for mill rolls, effects unusual economies in cleaning strip, sheet, bar stock and skelp.

American
WHEELABRATOR & EQUIPMENT CORP.
396 S. Byrkit St., Mishawaka, Indiana

WORLD'S LARGEST BUILDERS OF AIRLESS BLAST CLEANING EQUIPMENT

Pittsburgh, Pa. Mr. Weatherholt formerly was manager of the apparatus division's industrial department at East Pittsburgh. In his new post he will be located in downtown Pittsburgh, and will exercise staff supervision over the company's industrial products sales activities.

Stanley M. Hunter has resigned as vice president and director of American Hoist & Derrick Co., St. Paul, Minn.

J. P. McArthur was named manager of the Philadelphia, Pa., district sales office of Worthington Corp., succeeding the late **W. J. Daly.** Mr. McArthur was formerly regional manager of west coast sales. **H. W. King,** formerly manager of the San Francisco, Calif., district office has succeeded Mr. McArthur as regional manager, west coast sales. **P. L. McManus,** formerly resident salesman in Portland, Ore., has been appointed manager of the San Francisco district office.

Obituaries

John Lester Perry, 71, who was president successively of United States Steel's Tennessee Coal, Iron and Railroad Co.; Carnegie-Illinois Steel Corp. and Columbia Steel Co., died May 27 in Pittsburgh, Pa. Mr. Perry, who was 71, retired from active service on November 15, 1948. A native of Worcester, Mass., he rose from a steel plant clerk to the presidency in 1938 of United States Steel's then largest subsidiary, Carnegie-Illinois Steel Corp. Under his leadership Carnegie-Illinois amassed a record of accomplishments in the defense program, war production and peacetime reconversion that has not been equalled.

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HOT OR COLD BILLETS
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SAFETY
EYE and FULLERED
FORGING STAMPS

Furnished with one or more characters, these stamps have extra large shanks engraved with heavy bevels to withstand roughest service. Eye forgings available in single and double end styles. Non-spalling and non-mushrooming features of both styles are important safety factors.

Eye style stamps used with wooden handle—fullered style with wire handle.

M.E. CUNNINGHAM CO.
SAFETY STEEL STAMPS

105 East Carson Street • Pittsburgh 19, Pa.

Dr. Marcus A. Grossman, 61, advisor — research and planning, research and technology for U. S. Steel Co., died May 21. A native of Youngstown, Ohio, Dr. Grossman was graduated in 1911 from Massachusetts Institute of Technology and later took his graduate work and received a Doctor's degree at Harvard. For nearly all of his career, he was noted for his work with alloy steels and their heat-treatment. Among his early connections were the National Bureau of Standards, Vanadium Corp. of America, Electric Alloy Steel Corp. and Central Alloy Steel Corp. He commenced his service with U. S. Steel as a metallurgist at the South works of Carnegie-Illinois Steel Corp. in 1931, and in 1935 was promoted to director of research of the Chicago district, later being named director of research for the company. In 1950 he was named advisor — research planning, research and technology, of the United States Steel Co., of which Carnegie-Illinois Steel Corp. became a part in 1949.

George H. Rose, 73, retired executive of American Steel and Wire division of U. S. Steel Co., Cleveland, Ohio, died May 28. Mr. Rose began his career in 1905

GEORGE H. ROSE

when he went to work as a draftsman for the old Newburgh Steel Works and later was transferred to Central Furnaces in Cleveland. In 1917 Mr. Rose was transferred to Pittsburgh, Pa., where the steel company had its headquarters and where he remained until 1925 when he returned to Cleveland. In 1926 he was made assistant construction engineer and in 1937 chief engineer. He planned to retire in 1943, but remained because of the war emergency and was made assistant to the vice president. An expert on rod mills, he was responsible for installation of the Cuyahoga Works, in Cleveland, and rod mills in Joliet, Ill. and Donora, Pa.

Harry O. Johnson, 56, former general superintendent of American Steel & Wire's Central Furnaces & Docks in Cleveland, Ohio, and an assistant in the office of the vice president — operations of the U. S. Steel division, died May 22.

Howard T. Smallwood, 57, coordinator of raw materials for Jones & Laughlin Steel Corp., Pittsburgh, Pa., died May 10. Mr. Smallwood had been with J & L for 36 years.

Frederick D. Enterline, 54, purchasing agent for the Greenville Steel Car Co., Greenville, Pa., died May 20.

for **Dependable** Combustion Control and Metering in steel mills

Use HAGAN

Air-Operated Controls and Ring Balance Meters

Wherever you have combustion control and metering problems in steel mill operations, the dependable accuracy of Hagan Air-Operated Controls and of Hagan Ring Balance Meters assures reliable operation.

Hagan Engineers will be glad to help you plan your metering and combustion control systems.

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Individual Motor Drive

•350-TON, 6-MOTOR, 76′-0″ SPAN• LADLE CRANE BRIDGE

BUILT BY MORGAN Engineering

Illustrated is a 350-ton, 4-girder, 24-wheel Ladle Crane bridge with six individual motor drives.

The six motors are carried on the individual trucks, each motor being coupled to a worm reduction unit on the drive axle. With this type of drive, the usual squaring shafts are eliminated.

On account of the moving mass to be controlled, which would require the usual hydraulic brake for each drive, an air braking system is provided.

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SPECIAL MACHINERY FOR STEEL MILLS

THE MORGAN ENGINEERING CO.

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Equipment News...

NEW CIRCUIT BREAKERS

▲ A new line of outdoor power circuit breakers for distribution and subtransmission applications have been announced by the switchgear department of the General Electric Co.

The breakers, additions to the G-E Type FK-439 line, are available in ratings of 14.4 to 46 kv, 600 and 1200 amperes, and interrupting ratings from 250 through 1500 mva.

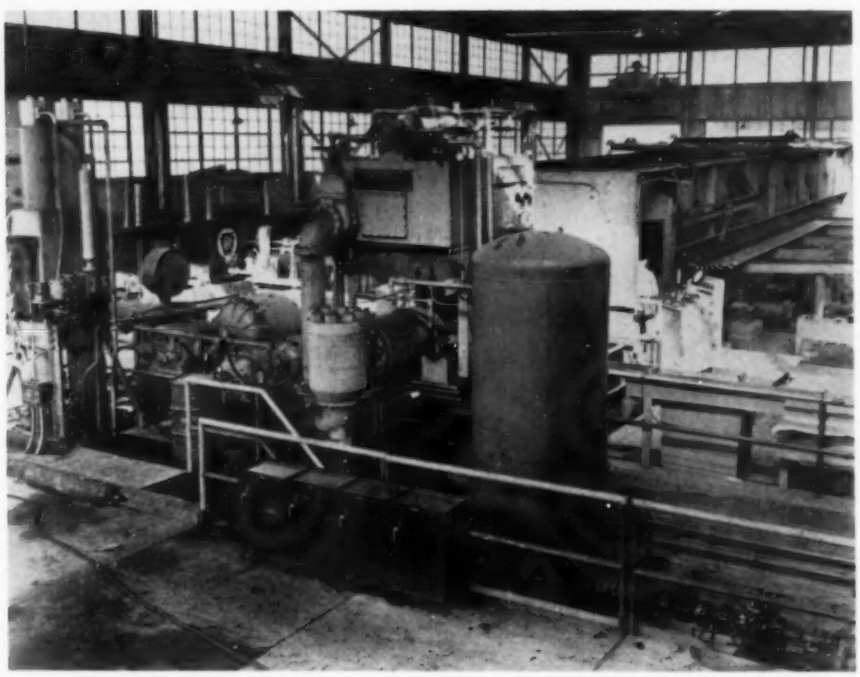
New oil-blast interrupters, used on the breakers, are designed to reduce oil carbonization by interrupting fault and load currents with short arc lengths and low arc energy. The interrupters have silver-molybdenum contact surfaces for low contact resistance and minimum erosion of contact material during interruption of fault arcs. They may be easily removed for contact inspection without disturbing breaker adjustments.

Maximum access to interrupters is provided by an open supporting frame. Convenient access is also provided to the pole-unit linkage.

The new units have oil-filled bushings with center-clamp construction, which eliminates all cemented joints. The lower ends of the bushings are coated with a special varnish that reduces the electro-static deposition of carbon particles on the bushing surface.

The operating mechanism of the breaker is pneumatically trip-free. The unit has a float-type oil gage and provision for two current transformers per bushing.

HIGH PRESSURE TESTING OF PIPE



High pressure testing of pipe at the Spang-Chalfant plant of National Supply Co., Ambridge, Pa., requires massive equipment on a foundation 112 ft long and 42 ft wide at one end, with water sumps 13½ ft deep. Hydraulic equipment is in the foreground. The vertical tank holds water for filling pipes before test and 100-psi air to reduce filling time. Pressure intensifiers at extreme left consists of two pairs of oil-water cylinders with common piston rods and overlapping delivery strokes. Oil cylinders below pressure-ize water in the top cylinders which transmit test pressure to the bench. The horizontal cylinder, which is on the centerline of the pipe under test, provides oil hydraulic back up force. It fills with oil from the rectangular tank above it when double-acting cylinders on each side advance the test head assembly carried on the crosshead of the main ram in this cylinder to the end of the pipe to be tested. Adjustment for greater differences in pipe length is provided by movement of the test head at the other end of the pipe.

EMERGENCY SHOWERS

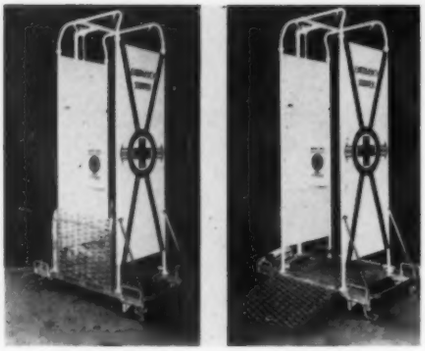
▲ To meet the increasing risks and hazards of fire, acids, and other contaminants to the human body, emergency showers are now being widely used. Instantaneous wetting and washing of all parts of the body and clothing of persons exposed has been found very effective in reducing serious injuries.

Emergency showers usually are installed at a point or points where they will be easily accessible to the largest number of persons involved. Now equal accessibility to the protection offered by emergency showers is being demanded for those employed at points of remote hazard or where physical conditions do not permit permanent installation of emergency showers.

To meet this demand, the Logan mobile emergency shower has been designed. It is a completely portable unit that can be moved from place to place quickly and easily, thus making protective equipment always available where and when it is needed. They can be used wherever a water supply is available. Couplings for connection to the water system in use in each instance are furnished with the unit.

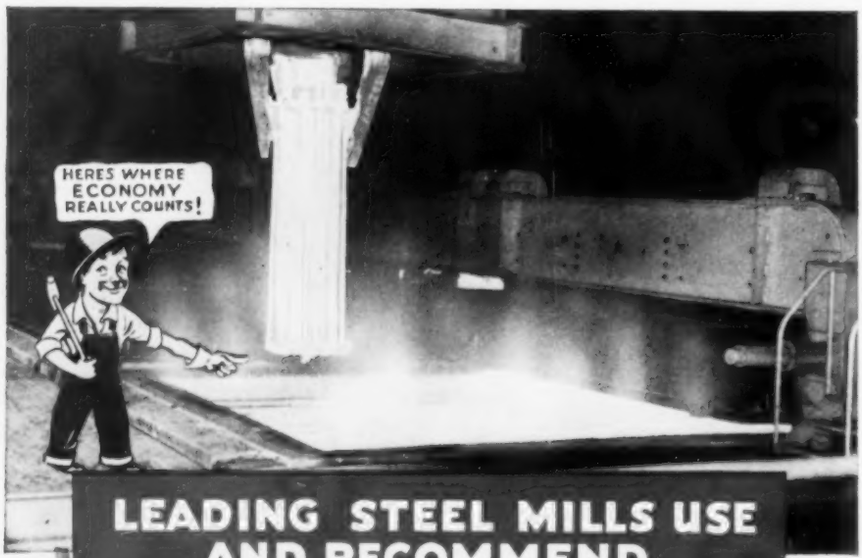
Mobility is achieved by easy rolling casters of ample size. The unit is held fixed in position by means of adjustable truck stops. A ramp is provided, for easy access to the shower, which locks into position out of the way when shower is being moved. Although only four men are required to load the shower on a truck, the construction employed in the base is so sturdy that it provides maximum stability even when exposed to reasonable winds. Sand bags or other ballast are normally not required.

This mobile shower embodies all of the features of advanced design that are incorporated in the new Logan emergency showers for permanent installation. The use of entirely new techniques in spraying water makes it possible with this unit to rapidly quench fire and, as shown by numerous tests, to rapidly dilute and remove acids or other chemicals and foreign materials contaminating clothing or



A ramp is provided for easy access to shower.

the human body. This amazing performance is accomplished by an ingenious arrangement of sprays — four overhead, two special sprays for eyes and face, and four bottom sprays that direct water upward under smocks, coats, etc. In addition, four streams are directed to the feet. Shower can be entered from either of two sides. Valve for turning on water is operated by swinging gate that is activated by slightest pressure applied by any part of the body of the user. Valve remains open until manually closed, leaving hands free.



LEADING STEEL MILLS USE AND RECOMMEND
BUCKEYE SILICA FIRESTONE
FOR LONGER SOAKING PIT SERVICE

What features do you require in your soaking pit linings—savings in fuel costs? . . . greater mechanical strength and rigidity? . . . low first cost and shorter installation time? . . . corrosion resistance? . . . much longer life? . . . freedom from repairs? . . . these features and many more can be enjoyed by you after you install Buckeye Silica Firestone.

Performance records prove that Buckeye is the best. Heads of masonry departments appreciate and recommend this modern refractory's money-saving installation possibilities . . . operators know how much longer service can be expected from a Buckeye-lined pit!

Steel mill executives, who have used Buckeye Silica Firestone for years, will give you many reasons for your specifying this up to date, better lining material for your soaking pits. Our service engineers will gladly work with you to obtain the finest possible results from your Buckeye installation. Ask for this service.

Send for free literature today!

THE CLEVELAND QUARRIES COMPANY
REFRACTORY DEPARTMENT
1740 E. Twelfth Street Cleveland 14, Ohio

BUCKEYE
"FOR THAT EXTRA SERVICE"
SILICA FIRESTONE

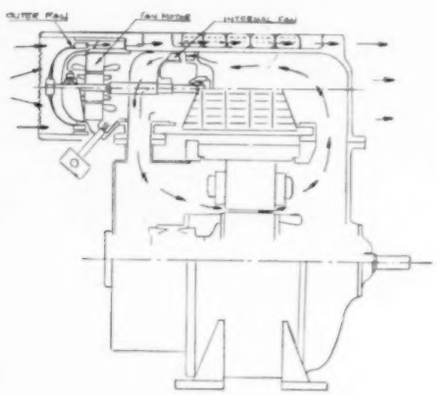
TOTALLY-ENCLOSED MOTOR

▲ The ever-broadening application of the Reliance all-electric, adjustable-speed drive has increased the need for a totally-enclosed motor which by virtue of special cooling provisions could be built in relatively large horsepower ratings for those situations where it is necessary for the motor to be given extra protection from atmospheric conditions.

This need becomes quickly apparent when it is realized that adjustable-speed drive motors, unlike conventional d-c motors, must operate over an extremely wide speed range. Today, ranges of from 200 to 1800 rpm are becoming increasingly common, and speed ranges of as much as 100 to 1 are finding their way into modern industrial processes.

In many instances, especially where the drive motor must be protected from bad atmospheric conditions, the unit must be enclosed; and, when enclosed, must be properly cooled within itself, preferably by clean air.

To meet this type of service, Reliance Electric & Engineering Co. has developed what may be termed a totally-enclosed, dual cooled motor,

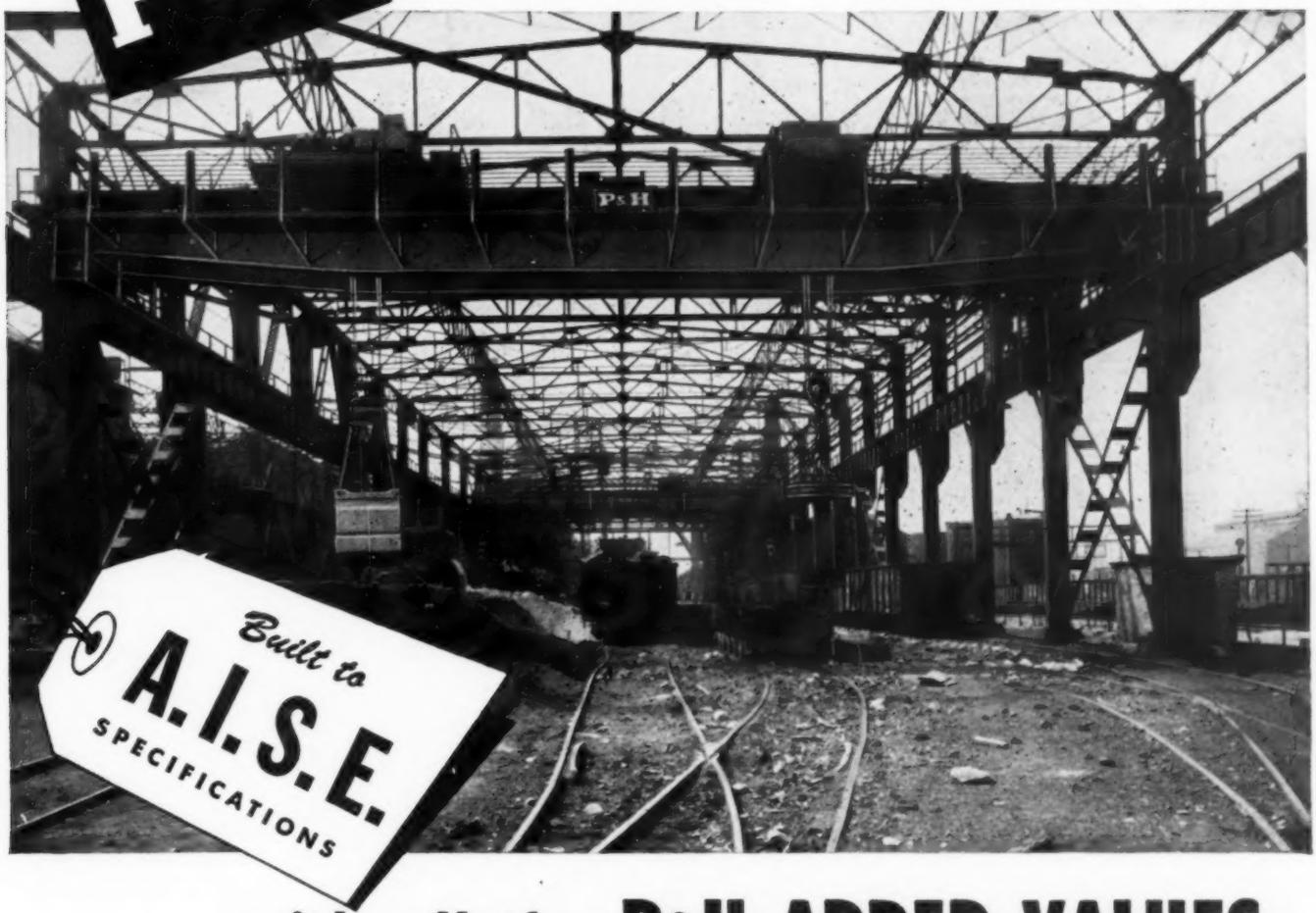


equipped with a heat exchanger as an integral part of its own frame. A 1½ hp, 3 phase, 60 cycle motor, built into the heat exchanger, runs at 3600 rpm to drive internal and external fans independently of the main motor itself.

The heat exchanger sections are cast aluminum with both internal and external fins for maximum heat dissipation. Air velocity through the internal sections of the exchanger is 2900 fpm. In the external path between the cover and the exchanger bank the air is pumped at 3300 fpm.

It is expected that there will be little need for cleaning the outside of the exchanger bank except where

P&H MILL TYPE CRANES



. . . with all the P&H ADDED VALUES Steel Men want!

Three Gear Case Bridge Drive
delivers motive power to end trucks, perfectly equalized. Mill motor is connected to gear case at center of span, which transmits power equally to the gear cases in front of each end truck.

No Open Gears at Trucks—
gear reductions are completely enclosed in sturdy all-welded cases. All gears run in oil — quietness and long life are insured with all gears operating in oil baths. No exposed gears; no dripping grease.

Flexible Couplings at Wheel Shafts
assure smoother starts — maximum bearing life and prevent thrust from entering gear cases.

Split Gear Cases
are designed to simplify inspection and maintenance.

Large Diameter Cross Shaft
combines maximum strength with low torque to minimize strain.

Hoist Sheaves
readily accessible from trolley deck. All hoist gears, including drum gear and pinion, run in oil.

Trolley Frame
and bridge ends are line bored and milled.

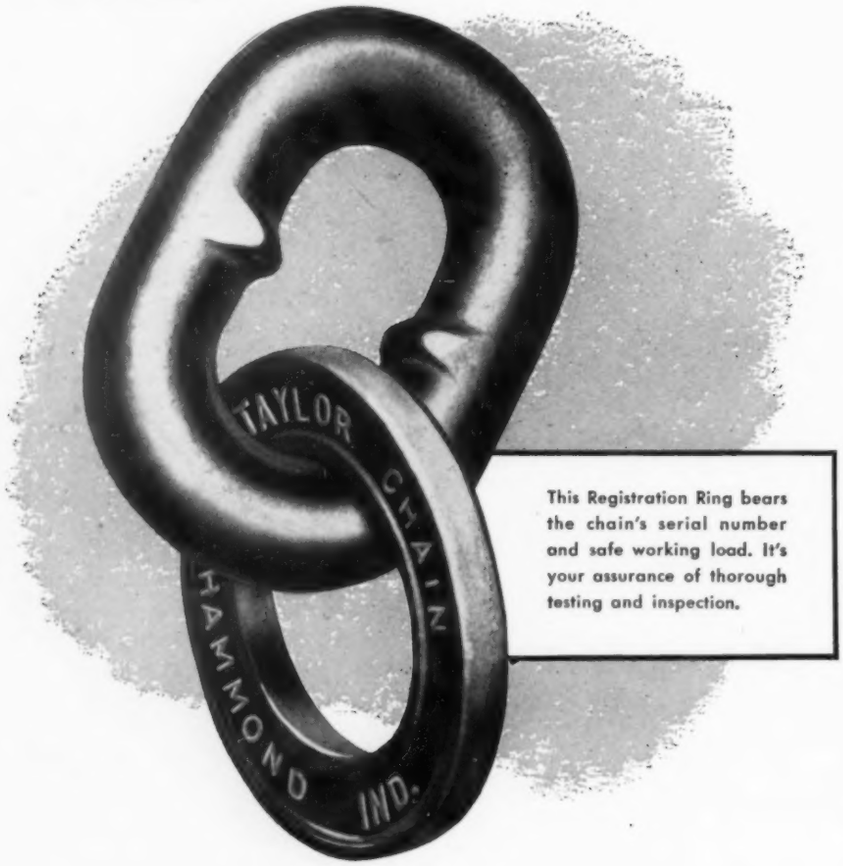
P&H Motors,
brakes and controls are available.

These and many other Added Values explain the preference which accounts for more than 2,000 P&H Cranes in steel mills. P&H Mill Type Cranes are described in Bulletin C-42. Ask for your copy.

P&H **OVERHEAD CRANES**
4455 West National Avenue
Milwaukee 46, Wisconsin
HARNISCHFEGER CORPORATION

POWER SHOVELS • CRAWLER AND TRUCK CRANES • OVERHEAD CRANES • HOISTS • ARC WELDERS AND ELECTRODES • SOIL STABILIZERS • DIESEL ENGINES • PRE-FAB HOMES

TM Alloy Steel
CHAINS
DO MORE WORK, LAST LONGER,
COST LESS . . . THAN WROUGHT IRON TYPES



This Registration Ring bears the chain's serial number and safe working load. It's your assurance of thorough testing and inspection.

Your chain problems are substantially reduced when you buy TM Alloy Steel Chain. Records prove this famous chain *outlasts* and *outperforms* wrought iron types . . . even under the toughest conditions. It's more economical too!

TM Alloy Steel Chain has twice the tensile strength. Controlled heat-treatment assures a uniform hardness of from 265 to 285 Brinell. These features make it highly resistant to abrasion, cold-working, grain growth and shock at all temperatures.

← *Send for free booklet* containing all the facts and specifications on TM Alloy Steel Chain and attachments.

S. G. TAYLOR CHAIN COMPANY
Dept. 5, Hammond, Indiana
Rush literature and prices on TM Alloy Steel Chains.

NAME _____

ADDRESS _____

TAYLOR MADE
A GREAT NAME IN
Chain SINCE 1873

there is a wet clinging dust in the surrounding atmosphere. Under such conditions cleaning becomes a simple matter of removing the exchanger cover and wire brushing the exchanger bank.

The new design also simplifies maintenance. Heretofore, many enclosed ventilated motor designs have made use of small tubes or similar devices for dissipating heat which are extremely difficult to clean. In the new Reliance design, the use of wide exposed aluminum fins, plus the high velocity at which the air is swept past them, tends to keep them clean. Should they become fouled with foreign matter, they can still be easily cleaned inasmuch as removal of the cover makes the exposed fins readily accessible.

In addition to the better overall cooling provided, this new Reliance dual-cooled motor design provides a number of other advantages. Because cooling efficiency has been increased, use of smaller motors for a given horsepower is possible. This, in turn, enables Reliance to build totally enclosed motors up to 150 hp — double the limit previously imposed.

The new dual-cooled design also enables Reliance to build motors in all these sizes for use in hazardous atmospheres, such as coal mining, and for difficult industrial applications. The new units are available in sizes up to 150 hp with Underwriters and Bureau of Mines approval.

BALL VALVE

▲ A new ¼-in. ball valve of unique construction, recommended for working pressures up to 3000 psi, is announced by Foxboro Co., makers of precision instruments for industrial process measurement and control. Descriptive details will be sent on request.

Tight, positive shutoff is provided by a stainless steel ball which closes into a machined, conical seat. The ball, retained at the end of the stem, is free-rolling so that every closing brings a new surface into contact with the valve seat. Alignment of ball to seat is accurately piloted by a forged steel, union-type bonnet, fitting tightly to the body and assuring a correct valve closure.

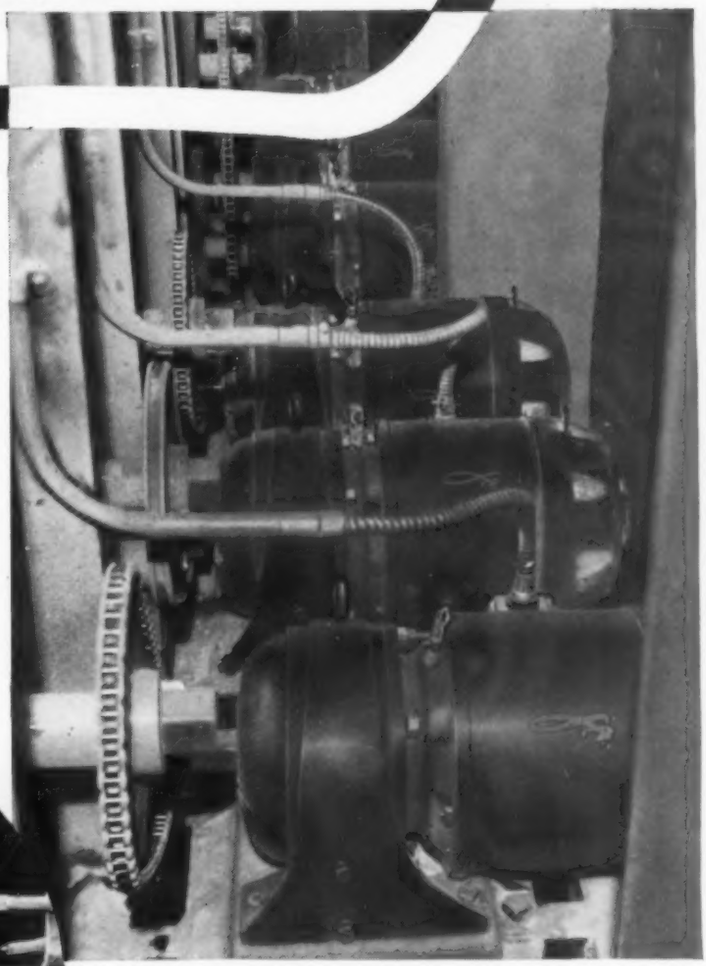
The long-stroke stem and the packing gland are made of stainless steel for durability and resistance to corrosion. The packing is a preformed,

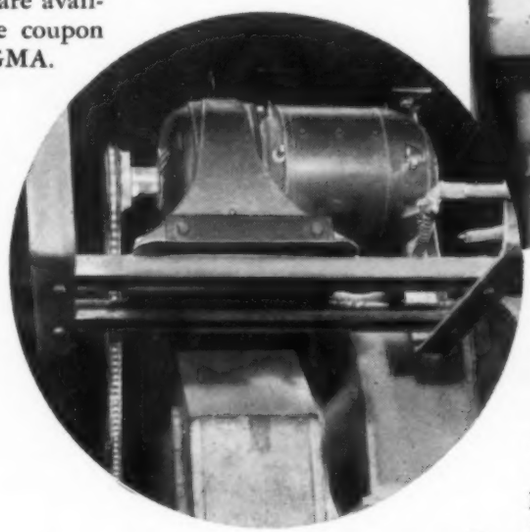
engineered for tough jobs ideal for ANY job

Here is a battery of Foote Bros.-Louis Allis Gearmotors at work for the International Milling Company in Detroit. Enduring heavy loads under excessive dust conditions, these units are providing positive, uniform power, day in and day out, under rugged service.

These Gearmotors incorporate Duti-Rated Gears with file hard surfaces and resilient cores, assuring maximum strength in minimum size. The cast iron housings give rigidity, and the large oil reservoir with splash lubrication means continuous, trouble-free operation.

Foote Bros.-Louis Allis Gearmotors are available in single, double and triple reductions to provide output speeds of 780 down to 7.5 r.p.m. Capacities from 1 h.p. through 150 h.p. Open drip-proof, splash-proof, enclosed and explosion-proof motors are available. Mail the coupon for Bulletin GMA.





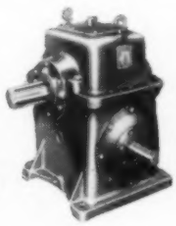
Foote Bros.-Louis Allis Gearmotors installed at the International Milling Company, Detroit, Michigan.

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
Dept. IAS, 4545 S. Western Blvd. • Chicago 9, Illinois

Line-O-Power Drives



Hygrade Drives

Maxi-Power Drives

Foote Bros. Gear and Machine Corporation
Dept. IAS, 4545 South Western Boulevard
Chicago 9, Illinois

Send me Bulletin GMA on
Foote Bros.-Louis Allis Gearmotors.

Name.....

Company.....

Position.....

Company Address.....

City..... *zone*..... *State*.....

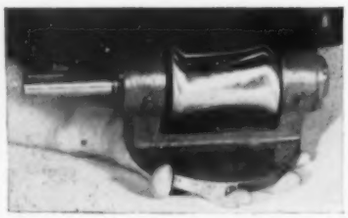
We Build Small Ones Too!

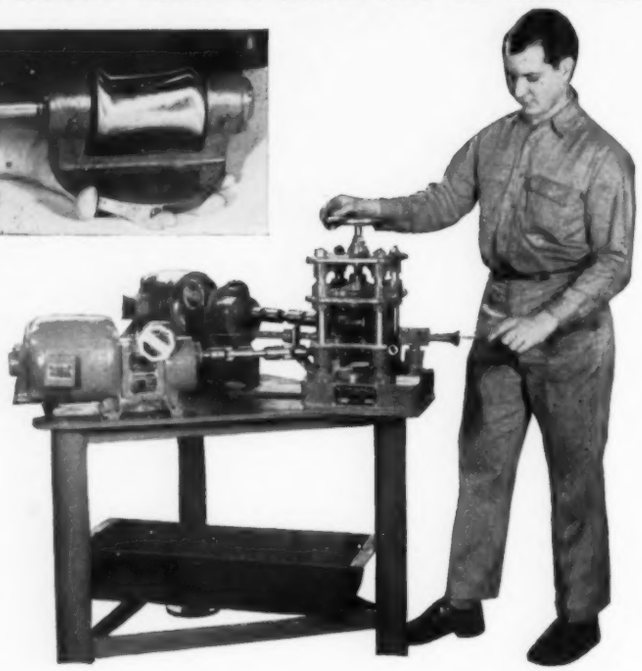
MEDART

No. 000 TWO-MOTOR TYPE

2-ROLL ROTARY STRAIGHTENER

FOR ROUND TUBES & BARS 1/16" TO 3/16" O. D.





- The smallest mill duty 2-roll rotary precision straightening machine made. Straightens, sizes, polishes and corrects out-of-roundness from end to end.
- Individual roll drive from variable speed motors equipped with integral speed reduction units, and interlocked for synchronization of roll speeds.
- Rolls made of Smavroc Alloy. Timken Bearing equipped.

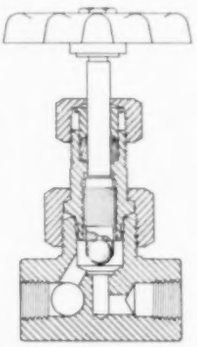
Large Or Small—Medart Builds Them!

2-Roll Rotary Straightening, Sizing & Polishing Machines for tubes and bars from 1/16" to 9" or larger—or multiple-roll straighteners for pipe or thin-wall tubes up to 24". Whatever the straightening job, a Medart machine will do it *faster, better and at lower cost!*

Write For Catalogs

THE MEDART COMPANY 3535 DE KALB STREET ST. LOUIS 18, MISSOURI

graphited asbestos with a plastic binder and can easily be replaced without shutting off the line pressure or interrupting the process. Straight-through and angle types are available with two and four connections, meeting the wide range of valve-design



Alignment of ball to seat is accurately piloted by a forged steel, union-type bonnet.

requirements found in general industrial use, as well as in pilot plants and laboratories.

Especially useful on meter manifolds, gage lines, seal chambers, bleed-off connections, sampling connections and lubricator shutoffs, the ball valve is universally adaptable in applications for liquid, gas and steam service.

ALUMINUM CONDUCTOR

▲ Development and availability of a new aluminum (third rail) conductor system with safety enclosures is announced by Electric Service Manufacturing Co. It represents the first completely integrated engineering approach to the third rail conductor problem for powering moving cranes of all types, ore bridges and allied materials handling equipment.

Trademarked "Keystone," the new system obsoletes the need of improvising structural shapes such as steel railroad rails or steel or copper angles, tees, bars or wire to feed power moving equipment.

The system is the development of a manufacturer which has offered a complete engineering and manufacturing service for conventional conductor and collector systems for the past fifty years. It is the result of a number of years of intensive engineering research and development and presents a radically new collector and conductor combination which solves the various problems which have heretofore annoyed users of this desirable metal.

The integrated aluminum system offers a conservative design capacity of 1000 amperes in a conductor which weighs only one-twentieth that of

personal contact . . .

a sure way to keep abreast of important developments in the Steel Industry

The big 1952 Iron and Steel Exposition will enable you to see and hear . . . in Person . . . key steel industry executives and operating men whose papers and discussions will give you a wealth of information on the industry's plans for the present and future. Time and money saving ideas on improved production methods, equipment, supplies and services exhibited by the world's leading manufacturers will help you improve your own position and do a better job for your company. You can't afford to miss it.

Write for free tickets today!

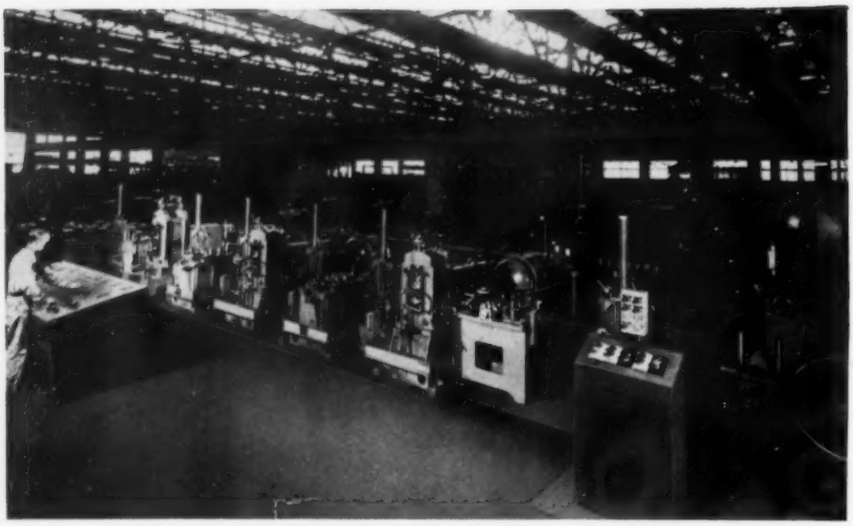
ASSOCIATION of IRON and STEEL ENGINEERS
1010 EMPIRE BUILDING • PITTSBURGH 22, PA.

ATTEND THE

1952 IRON and STEEL EXPOSITION

CLEVELAND
Public Auditorium

Sept. 30, Oct. 1, 2 and 3



American Brass does it Better, Faster, Easier with Torrington's HIGH-SPEED Flat Wire Mill

In the picture above, you're looking at the new Torrington Flat Wire Mill Line recently installed at American Brass Company's Ansonia plant. The superior features of this Line tell you why American Brass and other leading companies turn to Torrington for the best in Mill Machinery.

CHECK THESE SUPERIOR FEATURES

Capable of handling up to 3,000 feet per minute, and turning out 50,000 pounds of a size and more per 8 hour day.

Takes less time for a setup; requires fewer passes to produce finished material.

Maintains constant, yet adjustable, tension automatically during rolling. Dancer rolls easily added for extremely accurate control of tension and speed on very small wire sizes.

Spools on payoff and winder are power-loaded and unloaded.

Entire line may be equipped to stop automatically when desired length has been rolled.

Each separate unit in entire line is independently motor-driven.

All rolls are in pre-loaded precision-type anti-friction bearings, with special long-life lubrication built in.

All gearing is totally enclosed and runs in oil.

External coolant system for work and rolls; internal cooling on flattening rolls.

Mill lines may be assembled using 1, 2, 3 or more flattening stands, together with motor-driven edgers in any desired combination of units.

Works to tolerances as close as .00025" on thickness, .0005" on width.

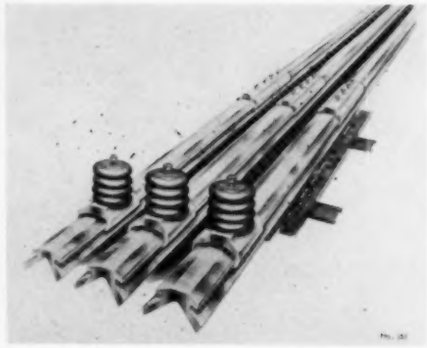
Torrington's decades of experience, gained from continuous collaboration with the world's foremost makers and fabricators of metal, are at your service to help you put a Torrington Flat Wire Mill Line — or any other Torrington machinery — to profitable use in your plant.

Call or write Torrington for information and name of nearest Torrington representative.

The TORRINGTON

MANUFACTURING COMPANY • TORRINGTON, CONNECTICUT

DESIGNERS AND BUILDERS OF MILL MACHINERY FOR SIXTY-FIVE YEARS



steel rail-copper booster combinations commonly used. It affords radical savings in cost and space requirements, and permits the safe, economical enclosure of heavy duty conductors. The overall installed economies and advantages of the system are such that it can be used for control and medium amperage conductors and can be economically applied in parallel to handle currents two or more times its normal rating.

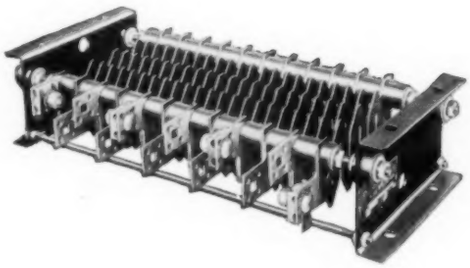
Many alloys of aluminum were considered and hundreds of contact materials were tested to determine the ideal combinations for various applications. A special collector design was then developed to apply the contact to a conductor so as to eliminate the possibility of rapid mechanical and electrical wear of either component. The absence of arcing permits safe high voltage operation. 4160 volts is being used on several current applications. The company offers a complete line of insulators particularly well adapted for this usage.

Maximum efficiency of current transfer has been accomplished through careful integration in design of collector, conductor and accessory components. Other important advantages of the system are elimination of corrosion problems, maintenance of conductor alignment, reduction of shipping, handling, erection and supporting member costs, allowance for differential expansion, freedom from icing on contact surfaces, elimination of high-cost copper booster cables, elimination of welding, and a reduction of other skilled erection labor costs.

Aluminum conductor contacts have far outlasted conventional components of steel systems on heavy duty applications and have performed satisfactorily on hydro-electric installations after extended periods of idleness.

Particularly desirable on long a-c installations because of its non-inductive nature, aluminum in the Key-

The welded grid assembly is shown here as a unit resting on narrow iron straps above its end frame, support rods, and spacers.



Cut maintenance with
Bulletin 942-A
TAB-WELD Plate Resistors

The alloy-steel used in these plate resistors has negligible resistance-change between cold and maximum working temperatures. In section form, the EC&M TAB-WELD design *maintains the original OHMIC value* of the section, unlike that of any other resistor section. TAB-WELD Resistor Sections are unequalled in that they do *not* depend upon end-clamping nut pressure for a continuous electrical path.

Also, there's *no burning* in concealed areas—at grid-eyes or at tap-plates. Note, too, the convenience of the tap-plates—welded in position. To shift the external lead-wire, only the terminal-block need be moved. The terminal-blocks are grooved to accommodate several sizes of wire, or flat-bus may be bolted to the terminal-plates.

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

WALDRON Improved Gear Type COUPLING

better built to eliminate sources of operating trouble

The steadily growing preference for these sturdy WALDRON couplings in all major industries is a tribute to the quality and workmanship that goes into them. Power is transmitted through solid forged steel hubs and one piece sleeves, for added assurance of safety at high speeds. All adverse and crank action on shaft and bearing is eliminated and an ever-present lubricant carries the load with no chance of wear from metal-to-metal contact. Their design permits use of smaller physical capacity for same size shaft. Their longer trouble-free service makes these couplings the most economical to buy and use.

By slight revision of standard basic design, these better built couplings can be provided for special applications.

WALDRON'S 40 years of coupling making experience is your assurance of a dependable product and expert service. Write for Catalog 57-A to get full particulars and engineering data.

JOHN WALDRON CORP.

NEW BRUNSWICK NEW JERSEY

Sales Representatives in Principal Cities

stone integrated system may be spaced on close centers to achieve low reactance drops previously obtainable only with copper systems.

Aluminum also is available without priorities and at an overall complete system cost, including collectors, insulators and mounting brackets which is often less than the cost of conventional copper angle conductors alone. Economical safety enclosures are offered to suit individual requirements.

HEAVY DUTY CLEANER

▲ Magnus Chemical Co. has recently completed a study of the cleaning operation on dismantled cranes, conveyors, etc., as used in the steel and heavy machinery industries. Parts of this equipment, such as gears, gear boxes, electric motor frames, shafts, buckets, heavy castings, etc., have to be cleaned when this equipment is torn down for maintenance or repair. Frequently accumulations of grease, oil, mill dirt and paint have gone on for years, with the result that the deposits are heavy and difficult to remove.

This type of cleaning calls for a heavy duty alkaline cleaner, to insure fast attack on the dirt deposits. The fact that paint will also be removed from all parts cleaned in such a heavy duty cleaning solution is no objection since repainting is a normal part of the job.

Magnus heavy duty cleaner 63 has been found most suitable for this cleaning operation, in comparison with other alkaline cleaners now offered for this purpose. It was found that while the same concentration of this cleaner is required to make an effective cleaning solution as with competitive cleaners, the time required for cleaning was much less, about one-half that of most other comparable cleaners.

Cleaning is usually carried out in heated tanks in which a 6 oz per gal water solution of this cleaner is kept at boiling temperature. Parts are loaded into this tank (in many plants, two or more tanks are used) and boiled out for about 3 hours, after which the parts are removed rinsed in hot water and allowed to dry. Most parts are heavy enough to self-dry with the heat remaining from the rinsing.

One very important point was developed in this study. In not a few plants it was discovered that the clean

Pickling tank and wash tank at Laclede Steel Company. Note the rolls fabricated from tough corrosion- and wear-resistant Ampco Metal. Roll dimensions 31" OD x 29" ID x 36" long. Side plates 34½" OD x ½" thick with 5" ID for shaft.

Here's another roll used at Laclede. Fabricated from money-saving Ampco Metal, it handles six strips at a time.

Laclede Steel
fights wear and corrosion in its pickling line with
AMPCO METAL*

...keeps production up...costs down

Steel companies throughout the country are faced with terrific production problems. Laclede Steel Company, St. Louis, like so many others, found one answer in Ampco Metal.

Shown here is their pickling operation. The tank carries a 12% sulphuric acid solution at 200°F. The strip enters the tank and goes through the entire process via wear- and corrosion-resistant Ampco Metal rollers.

The rollers and side plates are fabricated from Ampco Grade 8 plate. Shafts and nuts are made from extruded Ampco Grade 15.

But resistance to corrosion in pickling service isn't the only important feature of Ampco Metal. It also resists wear, shock, impact. That's why so many mills use Ampco Metal screw-down nuts, slippers, wear plates, flash-welder dies.

If you have a corrosion problem or a wear problem, it pays to investigate the advantages of Ampco Metal. See your nearby Ampco field engineer or write us for details.

AMPCO METAL, INC.
Dept. IS-6 • MILWAUKEE 46, WISCONSIN
West Coast Plant • Burbank, California

*Reg. U. S. Pat. Off., Ampco Metal, Inc., Milwaukee, Wis.

AMPCO®

G-11

A new development worth investigating . . .

GOODMAN SHAKER CONVEYOR

for moving hot and abrasive materials

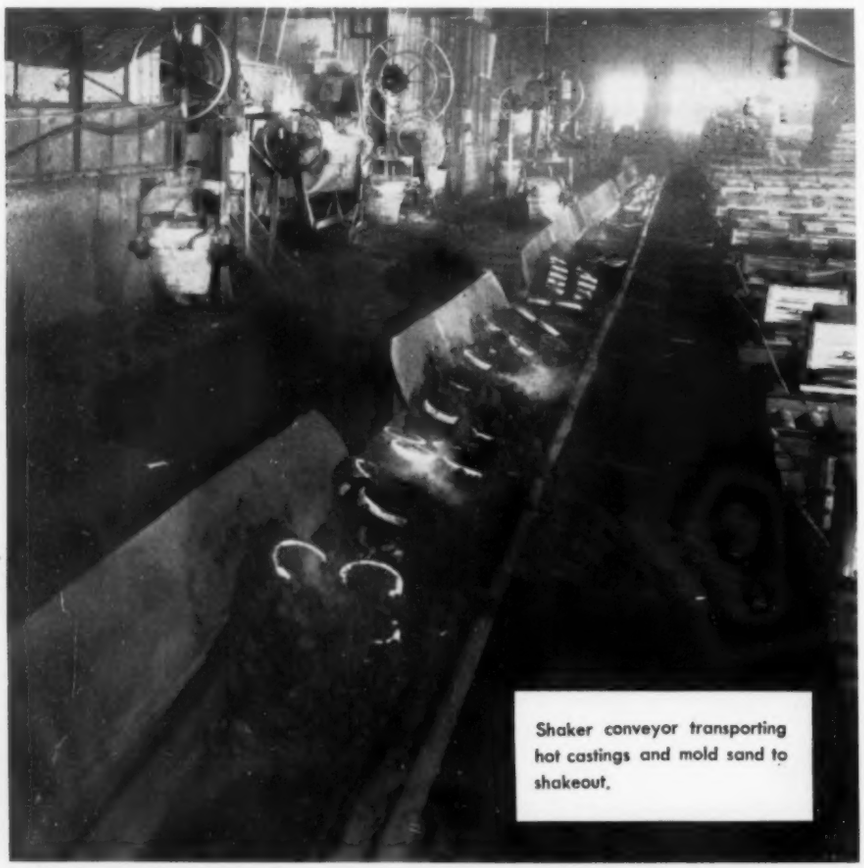
HANDLES THE ROUGH JOBS — Transports hot, abrasive, wet or dry materials: coke, sinter, dolomite, steel scrap, mill scale, castings, silicon carbide, bauxite, and other ores.

VERSATILE — Adaptable to short or long distances, small or large tonnages — upgrade, downgrade, or on the level. Powered by electric or air drive.

ENGINEERED TO YOUR CONDITIONS — This special Goodman service assures you of a trough line and drive unit exactly right for ***your*** job — a conveyor system that will give you high continuity of operation, low maintenance cost.

52 YEARS' EXPERIENCE IN MATERIALS HANDLING EQUIPMENT

Write for Bulletin IMD-498



Shaker conveyor transporting hot castings and mold sand to shakeout.

GOODMAN MANUFACTURING COMPANY

INDUSTRIAL MANUFACTURING DIVISION

Halsted Street at 48th • Chicago 9, Illinois

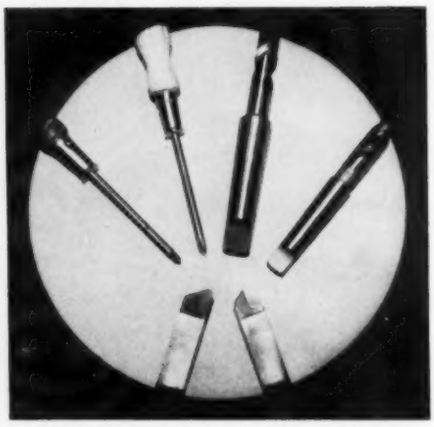
out tanks were being heated with live steam. In some cases, steam coils were used for the major part of the heating, with live steam being injected into the solution to speed heating and to provide agitation for the cleaning solution. Where too much dependence on live steam for heating was found, there was a corresponding dilution of the strength of the solution due to dilution with condensed water. In fact a number of tests showed that where it was assumed that the normal concentration of 6 ounces of Magnus 63 per gallon of water was being maintained, the actual concentration was below 3 ounces per gallon. When the use of live steam was reduced, concentration was maintained and cleaning time again became normal for the cleaner.

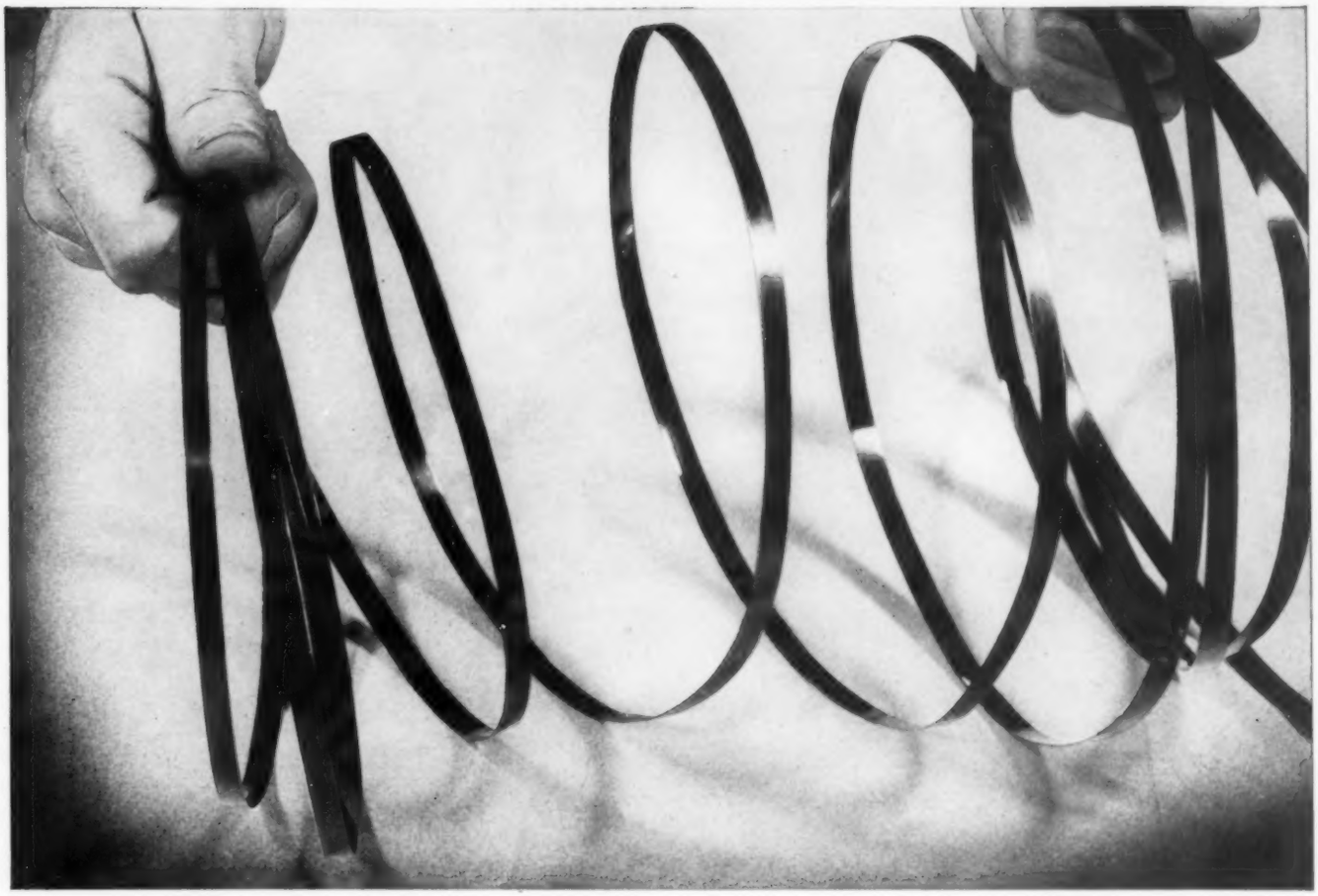
As a rule, limiting the use of live steam to speed heating only after evaporation has materially reduced the solution level will avoid excessive solution dilution. Additional coil capacity may be required in some cases to make up for the loss in heating action caused by the limiting of the use of live steam, but in general this is not required.

TOOL RECONDITIONING

▲ More than 100,000 factory tools headed for "retirement" have been put through a reconditioning process by Chrysler Corp. in the past year to extend their useful lives several times

Three examples show how worn-out or obsolete factory tools can be made to serve again in Chrysler plants. Screw-drivers at upper left show how worn tools can be made useful again by resharpening. Drills at upper right show how shank can be reworked to smaller size for other purposes. Tools at bottom illustrate that obsolescence may not mean scrappage if simple re-cutting can refit the tool to another job





SPLITTING HAIRS IN STEEL
with Askania Hydraulic Control

A Pittsburgh district steel mill slits this ¼″ rough edge from 15-ton reels of blackplate at 3,000 feet per minute with accuracy of ± 1/64″. They do this precision edge-positioning job with Askania Hydraulic Edge Position Control.

Askania Edge Position Control is a new use for the Askania Jet Pipe Regulator, long the educated muscle of the steel mill. Steel men asked for it, because they needed the dependability and simplicity of Askania in this control job.

Nothing touches the steel but a stream of low pressure air. Available force is practically unlimited. The equipment is low in cost. There is nothing delicate about it. It's built to take all the abuse that continuous operation in hard service can give it.

Find out now about Askania Edge Position Control. See your Askania Representative, or write for Bulletin 141.

ASKANIA HY-PERFORMANCE Hydraulic Controls

ASKANIA REGULATOR COMPANY

240 E. ONTARIO STREET • CHICAGO 11, ILLINOIS

A Subsidiary of General Precision Equipment Corporation

beyond normal, thus cutting costs while at the same time conserving defense-vital metals.

Worn-out screw drivers, obsolete drills and thousands of other "tired" tools that have completed their stint on production lines are routed to the long rows of bins in the department.

Some of these tools are reworked to conform to new specifications; others are reissued to other departments of the company where they can be used effectively for other purposes; still others are sold to suppliers who can use them in their operations, and, finally, those that cannot be repaired or reclaimed in any way add to the tonnage of Chrysler's intensive scrap metal drive.

Last year 70,000 separate items were supplied to plants from obsolete tool stores or surplus stocks held by other plants, and another 3600 were reworked to fit new specifications. Savings ran into thousands of dollars. In another separate operation 24,000 grinding wheels were either reworked to provide fresh surfaces or substituted for other functions. Many other obsolete tools are sold to Chrysler vendors, who can use them in their operations.

One example is the $\frac{9}{16}$-in. drill which is reworked to $\frac{1}{2}$ in. to meet other specifications, or an old drill worn too short for its present job which is sharpened and used again on another assignment. In one case the stubs of solid carbide turning tools were saved from scrappage by brazing a steel shank onto them, restoring the tool to its original length.

Effective control of the operation is accomplished by routing all tool purchase requisitions through the nonproductive material control department. This procedure is an industrial counterpart of a housewife checking her supply of canned soup before buying more.

By a careful screening of these purchase requisitions, the accompanying blueprints can be checked against tools in the obsolete stock bins. If an obsolete tool can be reworked to meet the blueprint specifications for not more than half the cost of the new tool, or if an obsolete tool used for another purpose will fit the new job, it is supplied to the requesting plant.

Those tools which are broken beyond repair or cannot be used in other operations become a part of the company's scrap metal drive. Last year 788,000 lb of worn-out tools were turned over to the Chrysler by-products department for disposal as scrap.

MEASURING DEVICE

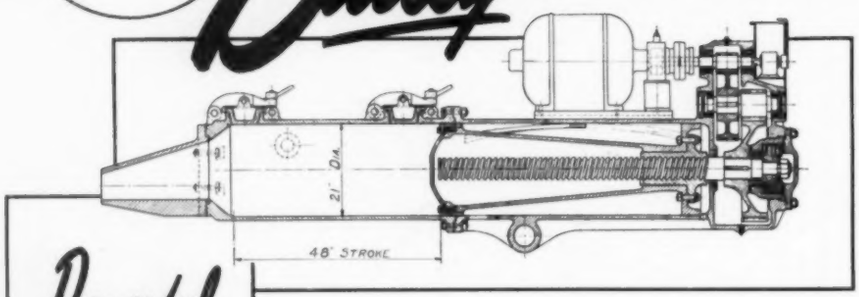
▲ A new device for measuring torque transmitted through small instrument ball-bearings under thrust loads, has been announced by the special products sales section of the General Electric Co.

Designed to act as a quality control check in both production-line and laboratory work, the new tester is able to show how the torque of a small ball-bearing varies as a function of angular position during a continuous slow rotation in either direction.

Basically, the equipment determines bearing torque by measuring

Long and Uniform Tapping Holes

Bailey CLAY GUN

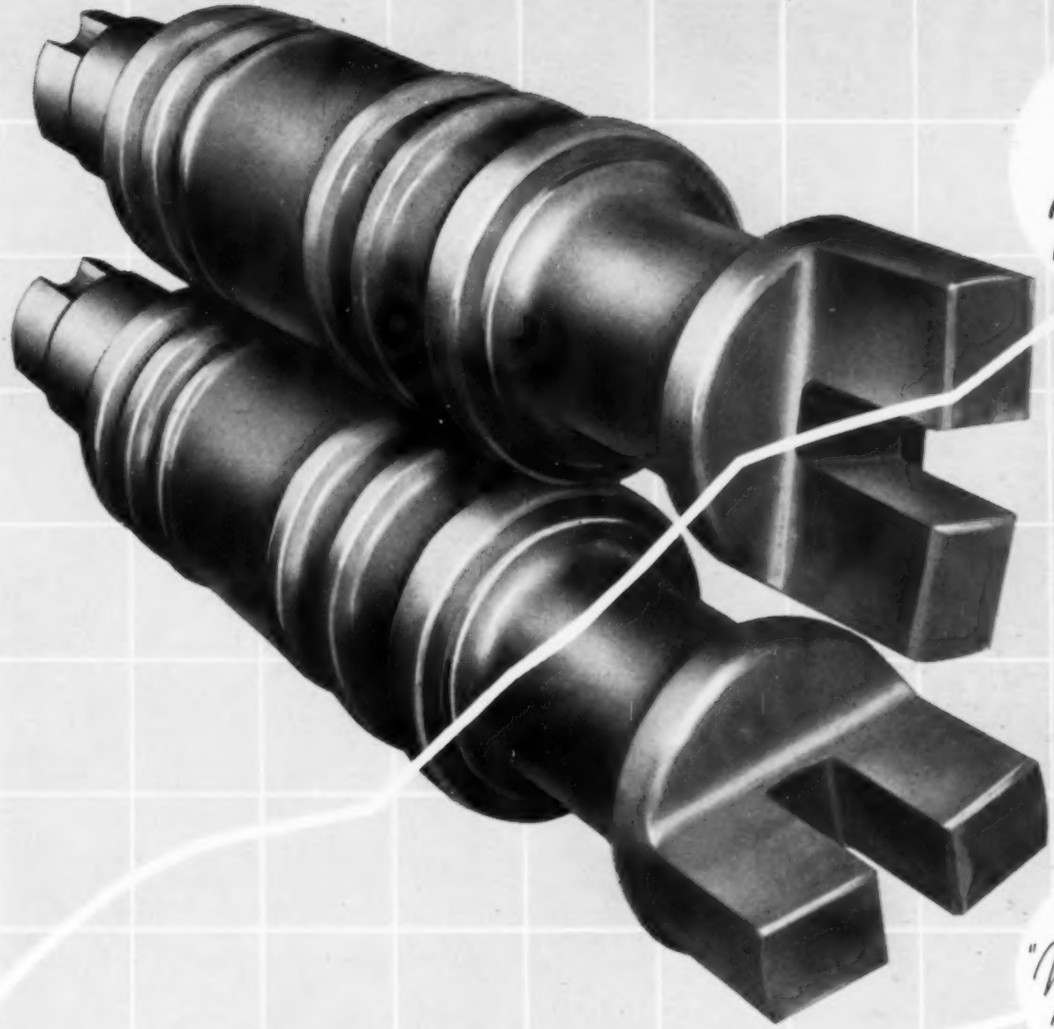


Powerful

A powerful electrically-driven piston assures unfailing performance.

Best results and safety in plugging blast furnace tapping holes are obtained with the Bailey Clay Gun. The special Bailey Lever Action forces the nose of the gun forward with positive accuracy. A powerful, motor-driven screw provides the piston pressure necessary to maintain long tapping holes.

WILLIAM M. Bailey COMPANY
ENGINEERS
LEADERSHIP THROUGH QUALITY
1221 BANKSVILLE ROAD PITTSBURGH 16, PA.



why you get "bonus" performance with

BIRDSBORO ROLLS

Topping "normal" production is easier when rolls are specifically designed and engineered to your own requirements. That's why you can *expect more* from Birdsboro Rolls.

From blueprint planning through analysis control for higher physicals, each step brings you closer to high, steady output with greater freedom from maintenance. If you're looking for long range rolling efficiency, at the lowest possible cost per ton—look to Birdsboro. The wide selection of Birdsboro alloy steel rolls, and copper grain rolls, assures you the rolling results you want.

Offices in:
BIRDSBORO, PA.
and
PITTSBURGH, PA.

BIRDSBORO
STEEL FOUNDRY & MACHINE CO.
Birdsboro, Penna.

ROLLS

Designers and Builders of:
Rolls • Crushing Machinery • Steel Mill Machinery
Hydraulic Presses • Special Machinery • Steel Castings

R-8-52

the current drawn by a torque motor in counterbalancing the bearing race torque as indicated by an electromagnetic pick-up.

According to engineers of the company's general engineering laboratory who developed it, the ball-bearing torque tester will save many manhours of assembly and disassembly by making possible the detection of dirty or defective bearings before their installation in an instrument. Number and magnitude of peaks, average friction, and tendency to bind under load all can be determined, they said.

In operation, the bearing to be tested is inserted in an adapter and both are then mounted in the tester. The inner race is clamped to the shaft of the device and the outer race is rotated one revolution in either direction by a drive motor.

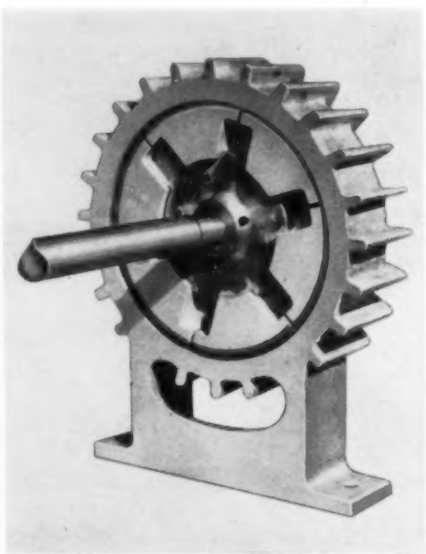
Torque from the outer race is transmitted through the ball bearings to the inner race and shaft, tending to rotate the shaft assembly and angularly displace an electromagnetic pick-up. A signal, proportional to this displacement, is generated in the pick-up and delivered through an electronic circuit to a torque motor. The motor, in turn, generates a counterbalancing torque, and, since the two forces tend to equal each other, the motor current is a reliable measurement of the transmitted bearing torque.

With the new tester, complete torque information is obtained in less than two minutes. The data can be either recorded on a recording milliammeter — which will give a complete picture of the torque — or indicated on a microrelay — a "go-no-go" gage. When the microrelay is used, any torques higher than a selected maximum will energize the microrelay to lock-in position and will indicate by means of a signal lamp that the selected value has been exceeded.

Designed to accommodate most bearing sizes commonly used in gyroscopic instruments, the mechanical unit is 6 × 9½ × 6 in. and weighs 13½ lb. The electronic unit is 17 × 8½ × 9½ in. and weighs 21½ lb, and the recorder, optional with the tester, is 10 × 13 × 11 in. and weighs 35 lb. The equipment operates on 115 volts, 60 cycles.

GOVERNING BRAKE

▲ A new governing brake, designed for use with electric or gasoline winches or similar power units, has been developed by St. Anthony Machine Products Co. Operating on a centrifugal governing principle, the brake delivers a smooth, gradual retarding action at any desired interval within a range of 900 to 4000 rpm's and automatically checks the speed of a free-falling or free running load. Engaging speed is pre-set at the factory



HERE'S HOW YOU CAN
INCREASE TONNAGE PICKLED

Use Heil Steam Jet Agitators For *Uniform* And *Complete* Agitation

E-3 TYPE JET FOR CONTINUOUS PICKLING

•**INCREASE TONNAGE PICKLED.** Field reports show increase in tonnage pickled from 20% to 40% due to this uniform and complete agitation.

E-3B FOR CONTINUOUS PICKLING

•**LONG SERVICE LIFE.** Patented Impervious Graphite nozzle construction gives longer service life under most severe operating conditions.

•**HIGH EFFICIENCY.** Standard designs are available to give uniform agitation in all type of operations. Continuous — Batch — Tube — Rod.

•**SAVES ACID.** Violent agitation makes possible the use of lower concentration of acid — thus reducing acid consumption.

Write today for illustrated Bulletin 43-A.

Contact One Of Our Application Engineers Today.

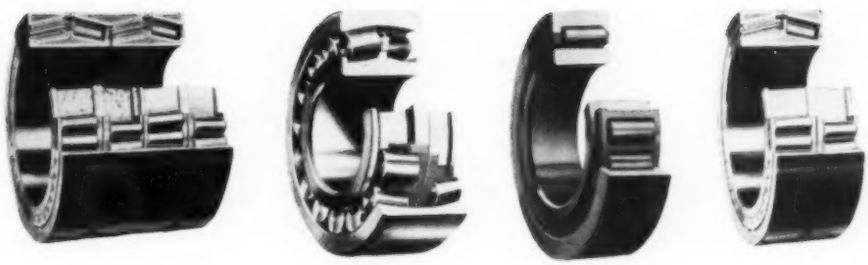
Representatives Located in all Principal Cities

HEIL PROCESS EQUIPMENT CORP.

12901 ELMWOOD AVE. CLEVELAND 11, OHIO

OTHER HEIL PRODUCTS INCLUDE: Lined Pickling Tanks • Acid-Proof Maintenance Material • Lead Fabrication • Monel Crates and Hooks • Lined Steel Pipe • Plastic Ducts

designed for harmony...



Torrington engineers have a thorough knowledge of the friction problems encountered in virtually every type of mechanical equipment. And they have had many years of experience with *all* types of anti-friction bearings. They are able to give sound, unbiased recommendations for the bearings best suited for the job at hand. Result: a harmonious blending of anti-friction bearing types with the products in which they are used.

Torrington engineers will be glad to help you—as they have many others—to select the bearings which will assure your products smooth, dependable operation.

THE TORRINGTON COMPANY

South Bend 21, Ind. Torrington, Conn.

District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Straight Roller • Needle • Ball • Needle Rollers

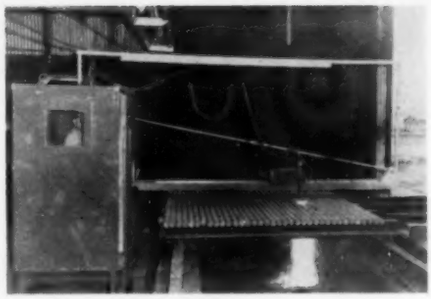
to the user's specifications by varying tension on the brake shoes.

Cast aluminum shoes with a bonderized, moulded lining present a braking surface of 26.5 in.; an aluminum-magnesium housing (Almag-35) with radial fins ensures high heat transmission and trouble-free operation.

The governing brake is primarily designed for shaft mounting, but is highly adaptable to special assembly requirements. Outside radius of the housing, including fins, is 9 in.; overall height with a floor-type mount is 11 7/16 in.; cross-section width is 2 11/16 in. The brake is also available with a flange mounted housing.

POWDER CUTTING

▲ When a hot saw at a billet mill could not keep up with mill production, a Linde oxy-acetylene powder cutting setup was installed to cut double-length billets in half. This billet cutting installation now makes an average of 900 to 1000 cuts per turn — better than three times the production formerly obtained.



The installation consists of three beds, and a carriage cab which mounts the equipment. While billets are being cut on one bed, the second is unloaded, and the third, loaded. In this view, as soon as the bed at right is cut, the carriage will move down to the bed at extreme left, which is ready for cutting. In the center bed, cut billets are being unloaded.

The carriage cab mounting the cutting equipment runs on tracks alongside the billet beds. An Oxweld cutting machine travels on a 10 in. machined I-beam which is fastened to the cab. The cutting machine cuts through the billets at 15 in. per minute.

An iron-rich powder is used in the oxy-acetylene flame to get quick starts. The operator, in the cab, controls the cutting operation.

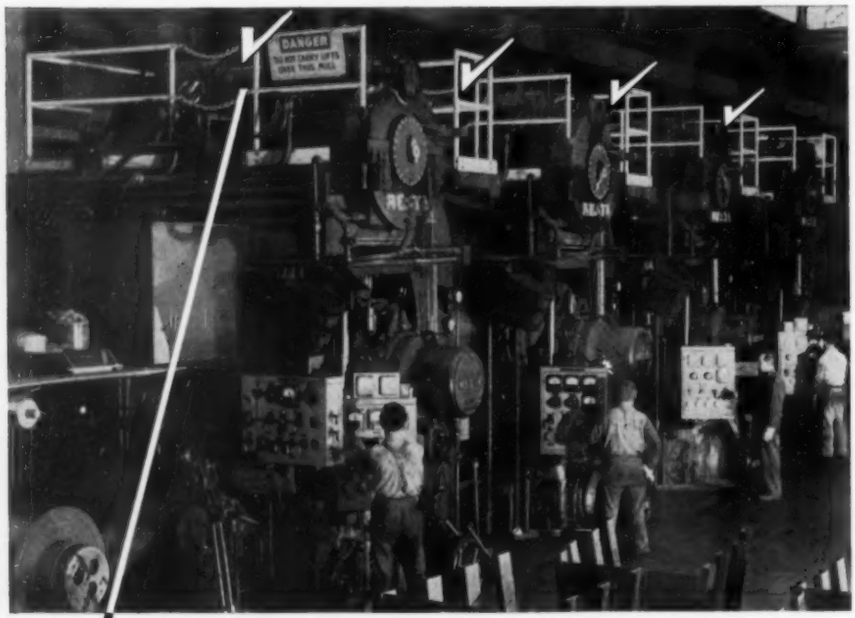
When the cuts on one bed have been completed, the operator disengages a clutch on the cutting machine, and returns it to the starting position by a pulley and cable drum arrangement. Then he moves the cab to the next bed and starts the operation all over again.

Four men make up the billet cutting crew: the operator, two chain men, who load and unload beds; and a crane operator. When all four men are kept busy, top production has gone as high as 1500 cuts per turn.

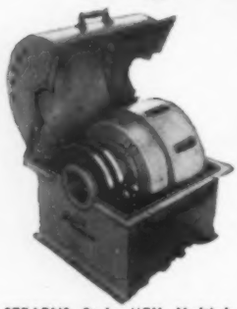
MILLING MACHINE

▲ Now nearing completion at the plant of Lewis Foundry & Machine division of Blaw-Knox Co. is a modernization program that significantly widens the scope of this producer of rolling mill machinery.

The program enables Lewis for the first time to compete for some of the largest types of rolling mills and related equipment. This is made possible by the installation of many new machine tools of larger capacity, as



Stearns KEEPS THEM ROLLING AT ALLEGHENY LUDLUM



STEARNS Style "E" Multiple Disc Magnetic Clutch fully enclosed in steel housing for steel mill application.

Synchronizing the drives of the screwdowns of a large mill requires a rugged, dependable clutch — a STEARNS Multiple Disc Magnetic Clutch. That's exactly the story of this installation, told four times! On each stand of this Mesta four high cold rolling mill at the Allegheny Ludlum Steel Corp., West Leechburg, Pa., there is a STEARNS Magnetic Clutch to synchronize the screwdown drives.

The newest and most powerful for its size, it is natural that this strip mill incorporate STEARNS Magnetic Clutches. Designed for just such steel mill applications, the STEARNS clutch is a low inertia unit of simple construction with no toggles, pins, yokes, shifters or other parts to wear and get out of order. Controlled by a push-button station, STEARNS clutches are available with taper-bores, detachable magnet hub, torques and construction to meet your screwdown requirements.

STEARNS EQUIPMENT FOR STEEL MILLS

Circular and Rectangular Lifting Magnets
Sheet and Pipe Conveyor Rolls
Magnetic Brakes and Clutch-Brakes
Drag Magnets and other steel mill magnetic specialties

Foremost in the Magnetic Field

Stearns MAGNETIC INC.

681 South 28th St., Milwaukee 46, Wis.

AMERICAN CHEMICAL PAINT COMPANY

AMBLER CHEMICALS ACP PROCESSES PENNA.

Technical Service Data Sheet
Subject: CHARACTERISTICS OF AND USES FOR RODINE®

A. SULFURIC ACID PICKLING

TYPE OF RODINE	POWDERED	POWDERED	POWDERED	LIQUID	LIQUID	LIQUID	LIQUID
FOAMING OR NON-FOAMING	FOAMING	NON-FOAMING	NON-FOAMING	FOAMING	NON-FOAMING	NON-FOAMING	NON-FOAMING
WITH WHAT ACID USED	SULPHURIC ONLY	SULPHURIC ONLY	SULPHURIC ONLY	SULPHURIC OR MURIATIC MIXTURES CONTAINING WEAK NITRIC	SULPHURIC MURIATIC	SULPHURIC PHOSPHORIC HYDROFLUORIC	SULPHURIC ONLY
WITH WHAT STRENGTH ACID	ANY PICKLING STRENGTH	ANY PICKLING STRENGTH	ANY PICKLING STRENGTH	ANY PICKLING STRENGTH	ANY PICKLING STRENGTH	ANY PICKLING STRENGTH	ANY PICKLING STRENGTH
TEMPERATURE LIMITATIONS	ANY PICKLING TEMPERATURE	ANY PICKLING TEMPERATURE	ANY PICKLING TEMPERATURE GOOD IN HOT ACID	PREFERABLY NOT OVER 180° F	ANY PICKLING TEMPERATURE GOOD IN HOT ACID	ANY PICKLING TEMPERATURE FAIR IN HOT ACID	ANY PICKLING TEMPERATURE GOOD IN HOT ACID
SOLUBILITY	PARTLY SOLUBLE READILY DISPERSED	PARTLY SOLUBLE READILY DISPERSED	PARTLY SOLUBLE READILY DISPERSED	SOLUBLE	MEDIUM READILY DISPERSED IN HOT ACID BATH	SOLUBLE	MEDIUM READILY DISPERSED IN HOT ACID
BEST SUITED TO TYPE OF STEEL	UNREACTIVE STEELS. O.H. STEELS. SHEETS. TIN PLATE.	UNREACTIVE STEELS O.H. STEELS. SHEETS TIN PLATE	REACTIVE OR UNREACTIVE STEELS O.H. OR BESSEMER SIMPLE OR ALLOY LOW OR HIGH CARBON	UNREACTIVE STEELS O.H STEELS STAINLESS STEELS	REACTIVE STEELS ALLOY AND M.C. ALSO O.H. AND UNREACTIVE STEELS	ANY TYPE STEEL	REACTIVE STEELS ALLOY AND M.C. ALSO O.H. AND UNREACTIVE STEELS
OUTSTANDING USES	FAST PICKLING. TIN PLATE. WHITE PICKLER.	FAST PICKLING. TIN PLATE WHITE PICKLER	FAST OR SLOW PICKLING TUBE AND PIPE ALLOY STEELS	FAST PICKLING. STAINLESS STEELS IN BATH CONTAINING WEAK NITRIC ACID	USED WITH SALT IN SULPHURIC PICKLE. CAN BE ADDED TO CONCENTRATED ACID	PICKLING FOR PLATING OR WHERE A SOLUBLE INHIBITOR IS INDICATED	USED WITH SALT IN SULPHURIC
USUAL PROPORTION FOR PICKLING	.25% TO 5% B.W. OF SULPHURIC ACID	.25% TO 5% B.W. OF SULPHURIC ACID	25% TO 50% B.W. OF SULPHURIC ACID	1/2 TO 1% B.V. OF SULPHURIC ACID	1/4 TO 1% B.V. OF SULPHURIC ACID	1/4 TO 1% B.V. OF SULPHURIC ACID	1/4 TO 1% B.V. OF SULPHURIC ACID
MISCELLANEOUS COMMENTS	WHEN ADDED CONTINUOUSLY MIX IN A THIN SLURRY OF DILUTE SULPHURIC ACID	WHEN ADDED CONTINUOUSLY MIX IN A THIN SLURRY OF DILUTE SULPHURIC ACID	ADD IN A SLURRY OF WATER OR ADD DIRECT TO BATH AFTER IT REACHES PICKLING TEMPERATURE	FORMS A HEAVY FOAM BLANKET	ADD DIRECT TO BATH AFTER IT REACHES PICKLING TEMPERATURE	CAN BE ADDED TO WARM OR COOL PICKLE BATHS	ADD TO BATH AFTER IT REACHES PICKLING TEMPERATURE
EFFECTIVENESS COMPARED WITH OTHER RODINES	MEDIUM	MEDIUM	STRONG	MEDIUM	STRONG	MEDIUM	STRONG

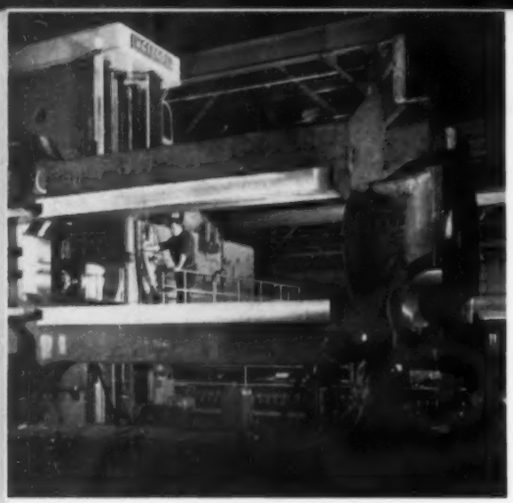
B. MURIATIC ACID PICKLING

TYPE OF RODINE	LIQUID	LIQUID	LIQUID	LIQUID	LIQUID
FOAMING OR NON-FOAMING	FOAMING	NON-FOAMING TO SEMI-FOAMING	NON-FOAMING	NON-FOAMING TO SEMI-FOAMING	NON-FOAMING
WITH WHAT ACID USED	MURIATIC AND SULPHURIC. MIXTURES CONTAINING WEAK NITRIC	MURIATIC	MURIATIC	MURIATIC	MURIATIC
WITH WHAT STRENGTH ACID	ANY PICKLING STRENGTH	ANY PICKLING STRENGTH	ANY PICKLING STRENGTH	30% TO UNDILUTED	30% TO UNDILUTED
TEMPERATURE LIMITATIONS	ANY PICKLING TEMPERATURE	COLD OR HOT GOOD IN HOT BATHS	LESS THAN 150° FAHR	FROM 100° FAHR UP	LESS THAN 120° FAHR
SOLUBILITY	FAIR	GOOD	GOOD	GOOD	GOOD
BEST SUITED TO TYPE OF STEEL	ANY	ANY	ANY	ANY	ANY
OUTSTANDING USES	WHERE A FOAM IS REQUIRED ON MURIATIC ACID BATHS	PICKLING. REMOVING LIME SCALE FROM EQUIPMENT IN WEAK MURIATIC SOLUTION	PICKLING IN WARM WEAK MURIATIC ACID PICKLING FOR PLATING	CLEANING OIL WELLS OR EQUIPMENT IN STRONG HEATED SOLUTIONS	CLEANING IN COOL STRONG MURIATIC SOLUTIONS
USUAL PROPORTION FOR PICKLING	1/8 TO 1/2% B.V. COMMERCIAL MURIATIC ACID	1/8 TO 1/2% FOR PICKLING. 2 TO 3% FOR CLEANING EQUIPMENT	1/8 TO 1/2% FOR PICKLING	1/8 TO 2% B.V. COMMERCIAL MURIATIC ACID	2 TO 3% B.V. COMMERCIAL MURIATIC ACID
MISCELLANEOUS COMMENTS	OTHER GRADES BETTER FOR CLEANING EQUIPMENT	CAN BE ADDED TO UNDILUTED MURIATIC ACID TO BE DILUTED	CAN BE ADDED TO UNDILUTED MURIATIC ACID TO BE DILUTED	WILL PLATE COPPER ON WORK IF USED IN WEAKER MURIATIC SOLUTIONS	WILL PLATE COPPER ON WORK IF USED IN WEAKER MURIATIC SOLUTIONS
EFFECTIVENESS COMPARED WITH OTHER RODINES	MEDIUM	MEDIUM	MEDIUM	STRONG	STRONG

CHEMICALS ACP PROCESSES

WRITE FOR DESCRIPTIVE FOLDER ON "RODINE" AND INFORMATION ON YOUR OWN PICKLING PROBLEM.

CHEMICALS ACP PROCESSES



well as by additions to the manufacturing space, crane capacity, and related facilities. The program also expands the volume capacity of this plant by 50 to 60 per cent.

Typical of the addition of modern machine tools of larger capacity, is the recent installation of a 409,000-lb milling and boring machine. This new machine cost more than $400,000 installed and is the largest unit of its type ever built by Ingersoll Milling Machine Co. The cutter is carried by a 24-in. ram and will extend into pockets as deep as 74 in. The head has a vertical travel of 12 ft and a horizontal travel of 46 ft. The spindle is driven by a 75-hp motor and the total motor power used to operate the machine is 195-hp.

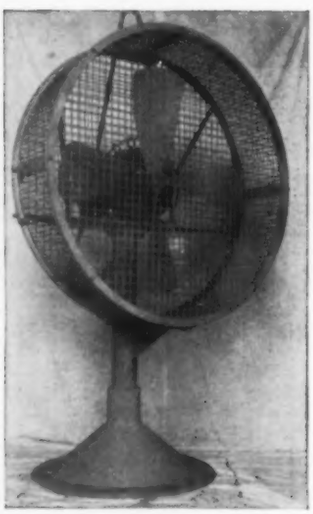
Lewis Foundry & Machine will use this new unit to machine mill housings and other large rolling mill equipment. Shown in the accompanying photograph is a view of the unit milling an 81-ton casting which is the housing for a 23 in. and 46 in. × 48 in. four-high hot rolling mill. Lewis is currently building two of these mills for export to Mexico.

IS HEAT SLOWING UP YOUR WORKMEN?

TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep them COOL

with TRUFLO FANS



TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS

TRUFLO FAN COMPANY

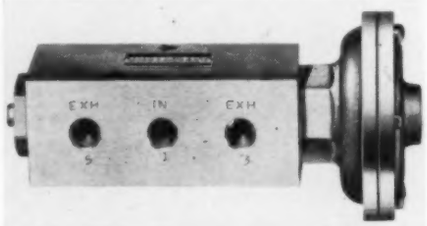
245 MAIN ST., HARMONY, PA.

DIAPHRAGM VALVE

▲ Newly introduced by C. B. Hunt & Son, Inc., the "Quick-As-Wink" diaphragm operated spring return single plunger valve pictured below is for use when only low pressure air is available for the pilot control. These valves can be operated with instrument air at pressures of from 12 to 35 psi on the diaphragm and consequently are well suited for use in development and research laboratories, and all types of industrial and commercial applications where only low pressure air for the pilot control is available.

These diaphragm valves are low in price. They feature sturdy construction — the utmost simplicity in design — and extreme ease of operation. All parts are carefully balanced. The valve housing is aluminum. The stainless steel plunger is hollow with precision placed radial ports. The spring return is placed under the diaphragm push plate permitting open end exhaust if desired.

The manufacturer reports that the improved design prolongs the life of the packing and valve parts, reducing

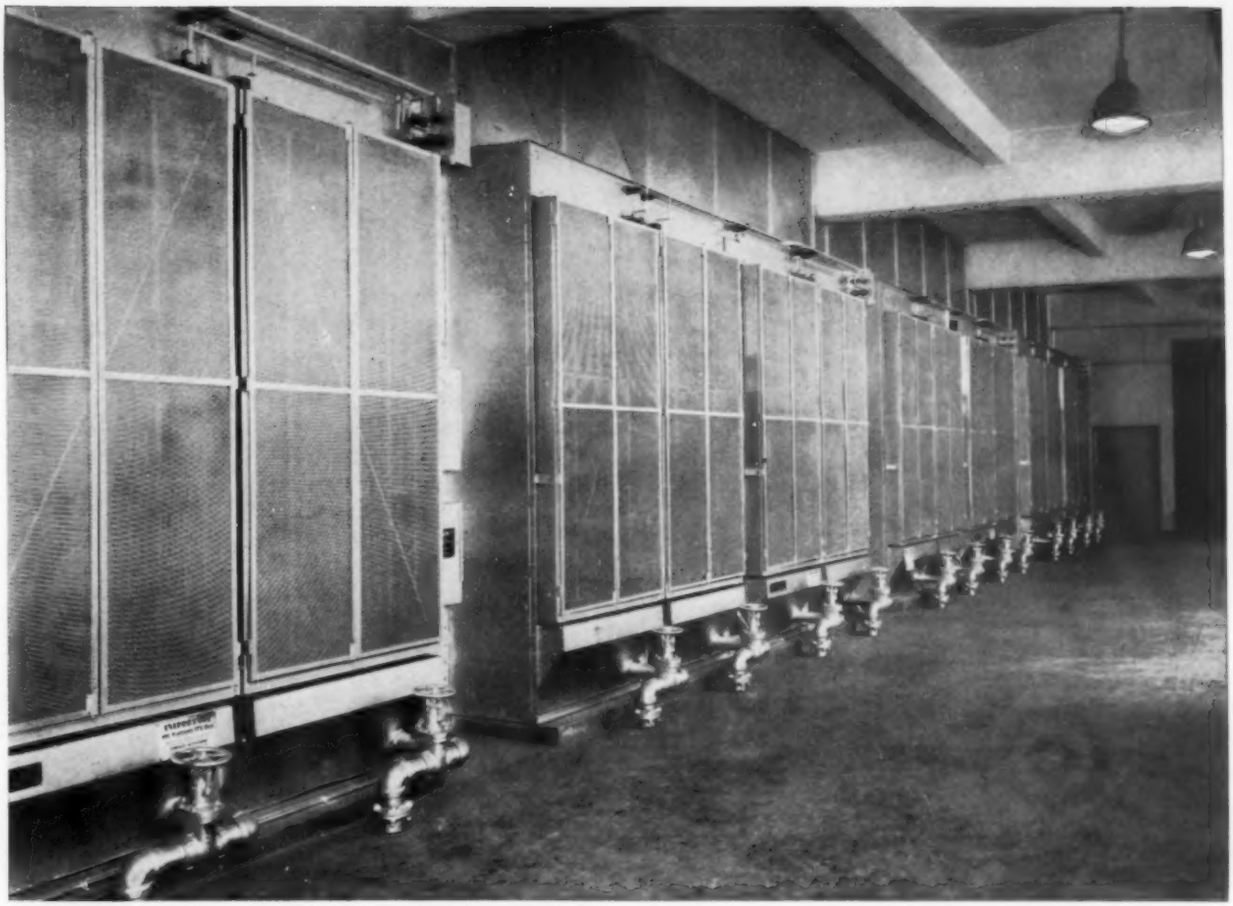


repairs and maintenance to a minimum — and that the valves can be completely disassembled and reassembled in a few minutes without disturbing the main piping.

Furnished tapped for either ⅛ in. or ¼ in. pipe connection, in 2-way; 3-way; double 2-way; 4-way; and 5-way designs for use with air, oil or water at line pressures up to 125 psi

(Continued on page 196)

today's best buy is better air!



AAF ELECTRO-MATIC *Precipitators totaling 175,000 CFM*

Electro-MATIC super-clean air

. . . MEANS LESS MAINTENANCE FOR MILL MOTORS!

STEEL MILL MOTORS perform more efficiently with less maintenance, if the cooling air is *super-clean.* Electro-Matic*, the *only* automatic, self-cleaning, electronic precipitator is widely used by steel mills to provide dust-free air for their motor rooms.

Highest cleaning efficiency is maintained by the Electro-Matic over a wide range of particle sizes, from smoke to the largest air-borne material. Due to the special design and spacing of its collector plates the filter curtain is non-clogging and insures uniform air volume. Also, the Electro-Matic's exclusive features of automatic operation and self-cleaning, reduce servicing to routine maintenance and insure maximum operating efficiency at all times.

The filters are standardized, self-contained sections, easily installed in various arrangements to meet any air volume requirements. Like so many in the steeel industry, the Electro-Matic installation above is equipped with oil clarifiers, which continuously clean the Viscosine and simplify sludge removal.

With thirty years experience in solving dust problems, AAF makes the *only* complete line of air filters and electronic precipitators. If *super-clean* air for motor rooms or other operations is one of your problems, call your nearby AAF representative or write today for Engineering Bulletin No. 250-E.

**ELECTRO-MATIC Automatic Electronic Precipitator.*

AAF **American Air Filter**

COMPANY, INC.

336 Central Avenue, Louisville 8, Kentucky

American Air Filter of Canada, Ltd., Montreal, P. Q. • Pacific Division Office, San Francisco, California

THERMIT WELDING
Speeds PUNCH to Steam Hammer

Serious losses in production threatened a large mid-western forging company, due to long delays in obtaining forgings the size of a complete 35,000 lb. ram. It was, therefore, decided to manufacture the ram for a steam hammer by joining two smaller forgings with Thermit Welding (Fig. 1) . . . a job which took only two weeks. The fabricated ram has seen many months of severe service (Fig. 2), and based on its excellent record, others are being built in the same way.

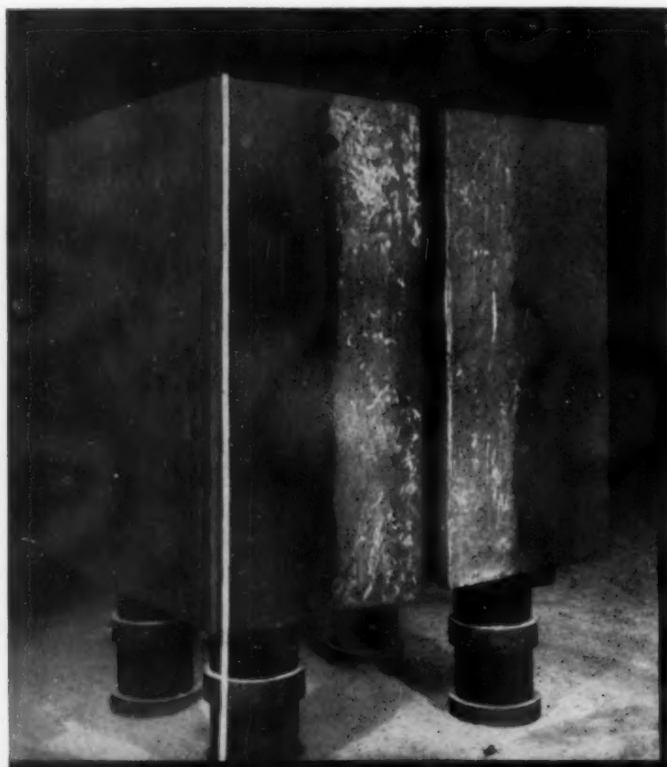


Fig. 1—Two forgings for ram in position prior to Thermit Welding.

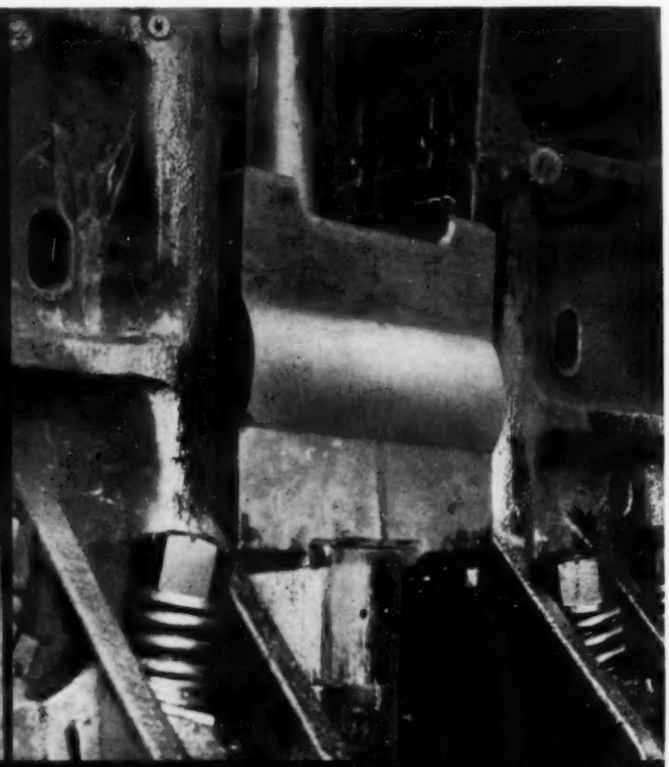


Fig. 2—Finished 35,000 lb. ram after fabrication by Thermit method.

CONSISTENTLY SOUND WELDS . . . MINIMUM OF TECHNICAL SKILL NEEDED . . . SPEEDY REPAIRS . . . LOWER THAN REPLACEMENT COSTS—four hard-hitting reasons for the swing to Thermit Welding in the repair, manufacture and maintenance of heavy drop forge industry equipment. Contact M&T on how Thermit Welding can help you!

THERMIT WELDING

METAL & THERMIT CORPORATION

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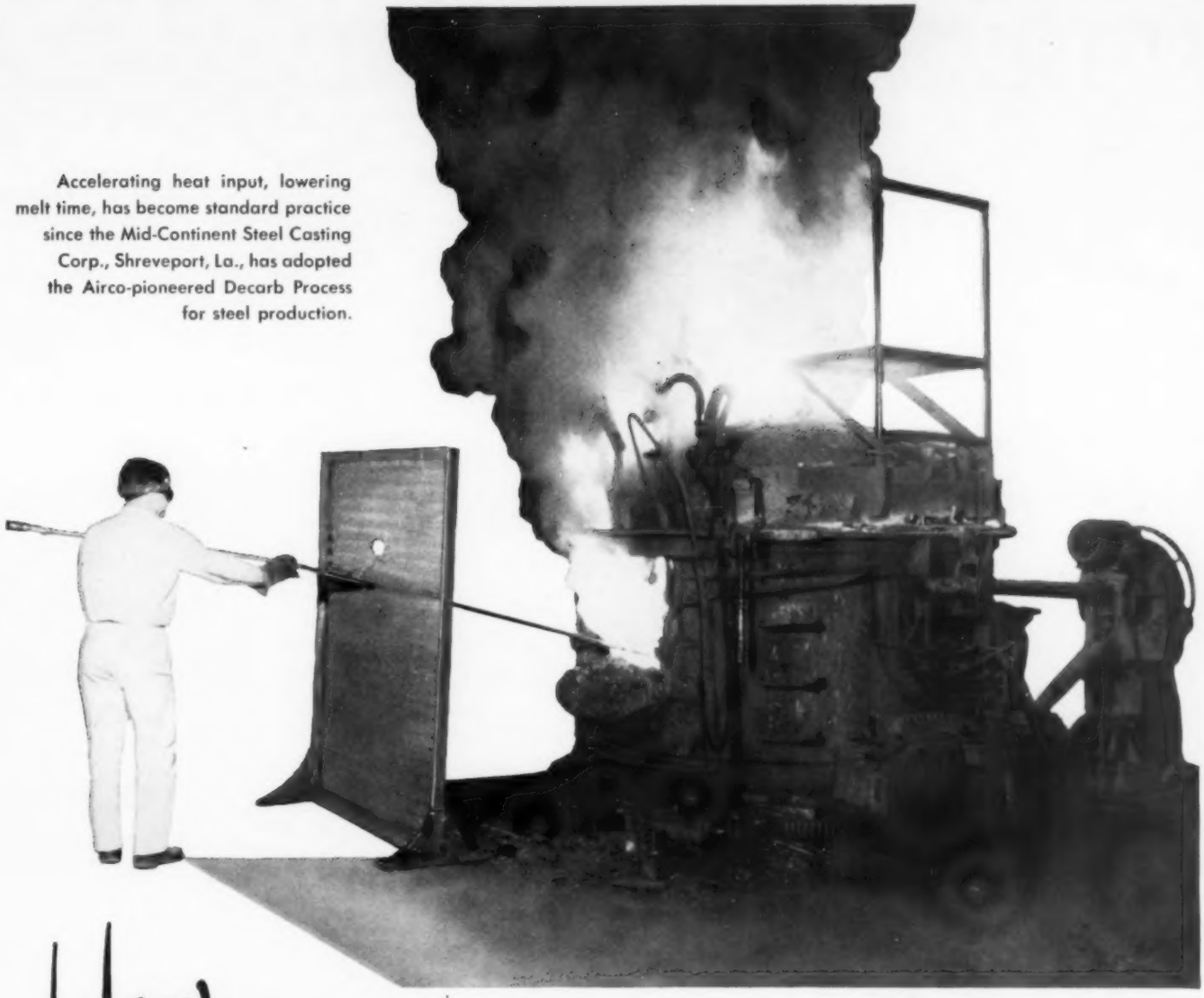

Accelerating heat input, lowering melt time, has become standard practice since the Mid-Continent Steel Casting Corp., Shreveport, La., has adopted the Airco-pioneered Decarb Process for steel production.

How TO INCREASE STEEL PRODUCTION

use less power–save more time

WITH AIRCO'S STEEL DECARBURIZATION PROCESS

Oxygen injected under the slag cover at 80 psi has become the answer to Mid-Continent's faster steel production.

Increased bath temperature—faster carbon elimination—lower power consumption . . . time saved per heat . . . gives Mid-Continent a product with the same normal chemistry, slag control and fluidity as they formerly received using ore. Additional work-flow advantages are gained by the elimination of ore handling and storage problems.

Oxygen decarburization for faster heats may be put to work for you. The facilities of our Technical Sales Division may furnish you with the answers you need to know about this process for your use. If you are interested in obtaining further information, please address your nearest Airco office.

AT THE FRONTIERS OF PROGRESS YOU'LL FIND

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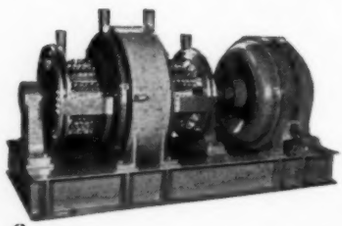

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EQUIPMENT NEWS

(Continued from page 190)

— also vacuum — at normal temperatures (not exceeding 150 F).

HUGE CRANE GIRDERS

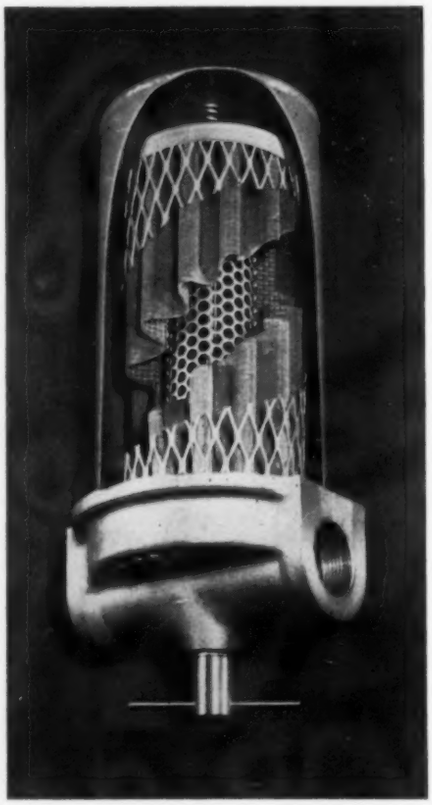
▲ Harnischfeger Corp. officials gave the railroads a stumper. Could the girders for a whopping 130-ft P&H overhead crane be shipped to a Pennsylvania steel mill intact? Time and cost savings would be considerable. Railroad people agreed, and scratched their heads to figure a way to transport the ungainly package. They then charted every curve on the right of way — particularly on bridges and underpasses — between Milwaukee and its destination in Pennsylvania. They found the load would clear. Picture shows the giant 10-ton crane

waiting at the Milwaukee plant to begin its carefully charted journey. Note how the middle car serves as a spacer only. Oddly enough, the tightest squeeze was getting out of the Milwaukee plant where clearance was only 2 ft on one side, 9 in. on the other. Cab, trolley, and other assemblies of the crane went along on two other flat cars. Thanks to meticulous planning on the part of the railroads, the customer not only got its new crane in one piece, but saved all along the line up to the final installation.

SYNCLINAL FILTERS

▲ Synclinal filters are now produced by Marvel Engineering Co. for filtering water. Adapting all models for water use is the result of many requests for the advantages of this balanced synclinal design.

Sump type is available in capacities from 5 to 100 gpm and the line type from 5 to 50 gpm. Monel mesh sizes from coarse 30 to fine 200. No changes have been made in the basic design.

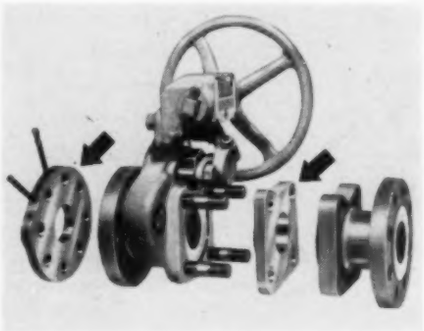


Line types still operate in any position and may be serviced without disturbing pipe connections. Both sump and line type models may be disassembled, cleaned and reassembled on the spot by any workman.

The balanced synclinal design provides maximum filtering area with a large capacity for accumulating filtered out matter, thus allowing longer periods of operations between cleanings.

HEATED VALVES

▲ Okadee Co. announces availability of what are believed to be the first commercially successful electrically-heated valves. Designed to keep valve mechanisms clear of frost and ice in liquid carbon dioxide lines at temperatures as low as −110 F, many other applications are being developed which include both hot, cold and viscous liquid and gas lines, as well as uses where heated valves have heretofore been economically impractical.



Single-disc Okadee valves require the heating element at right in the illustration. Double-disc valves can be equipped with both elements illustrated. Heat from the elements is transmitted directly to the valve seats, and as a result, heat the entire flow opening through the valve, in addition to the operating mechanism.

All heated valve sizes from 2 in. to 6 in. are available, with pneumatic, hydraulic, solenoid or manual control. Heating elements can be provided for either 110- or 220-volt operation, with inputs ranging from 400 to 3000 watts per unit. Heated valves for use in hazardous atmospheres will be offered soon.

Where flanged type Okadee valves are now in service, heating elements may be installed by simply exchanging standard studs for studs one inch longer.

THE 1952 IRON AND STEEL EXPOSITION WILL BE THE LARGEST IN AISE HISTORY. DON'T MISS IT!

September 30, October 1, 2 and 3
Cleveland Public Auditorium
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CRANES . . . FOR THE STEEL MILL

When your Steel Mill Cranes are "Shaw-Box," they are built with an intimate understanding of mill requirements, gained through years of working closely with the steel industry. Manufactured to exacting standards of fine engineering and precision workmanship, each one stands out as an example of the interpretation that can be made of individual mill or AISE specifications. Simple, rugged, and extremely accessible, they include the extra values of advanced design and construction excellence for which "Shaw-Box" Steel Mill Cranes are known and recognized throughout the industry. The plus advantages of "Shaw-Box" experience and precision manufacturing methods insure you trouble-free operation and dependability, with minimum maintenance costs, under the most severe operating conditions.

For the greatest value in dependably superior crane service you can buy, look to "Shaw Box."

BE SURE TO SEND ALL YOUR INQUIRIES FOR STEEL MILL CRANES AND SOAKING PIT CARRIAGES TO "SHAW-BOX."

SHAW-BOX CRANES

MANNING, MAXWELL & MOORE, INC. MUSKEGON, MICHIGAN

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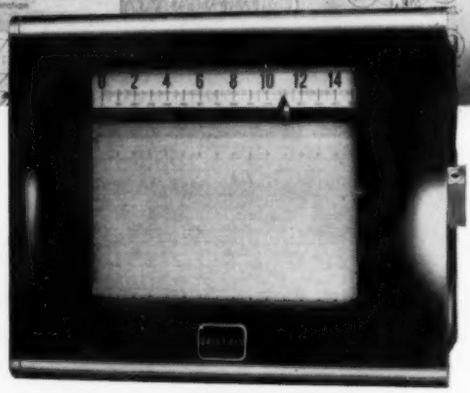
and chose the BRISTOL DYNAMASTER

Continuous-balancing electronic recorder



The instrument makers whose advertisements appear above know that their reputations depend upon the accuracy and reliability of their recorders. They select each component part with scrupulous care.

As the recording unit in their instruments, they all selected Bristol's Dynamaster. When you choose the Dynamaster for your own measuring needs you are assured of the same accurate, precise instrumentation demanded by these instrument makers.

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FOR MORE INFORMATION *on the uses of this versatile recorder, use the coupon to get Catalog No. P1245.*

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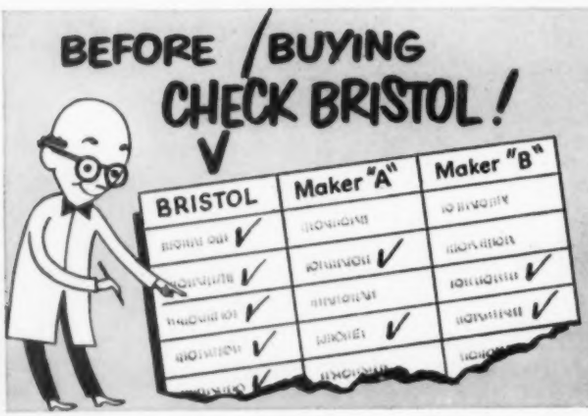

THE BRISTOL COMPANY
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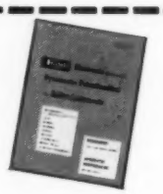
Waterbury 20, Conn.



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INDEX TO ADVERTISERS

JUNE, 1952

A

Adams Co., Inc., R. P. 194
Aetna-Standard Engineering Co., The 1
Air Reduction Sales Co. 193
Ajax Flexible Coupling Co., Inc. 158
Alliance Machine Co., The 121
Allis-Chalmers Manufacturing Co. 12, 13
American Air Filter Co., Inc. 191
American Bridge Div. of United States Steel Co. 156
American Chemical Paint Co. 189
American Manganese Steel Co., Division of American Brake Shoe Co. 159
American Wheelabrator & Equipment Corp. 167
Ampco Metals, Inc. 181
Askania Regulator Co. 183

B

Bailey Co., Wm. M. 184
Bantam Bearings Division of The Torrington Co. 187
Birdsboro Steel Foundry and Machine Co. 185
Bliss Co., E. W. 127
Bloom Engineering Co. 4, 5
Bonnot Co., The 45
Bristol Co. 145, 198
Brooks Oil Co. 22
Browning and Co., Inc., Victor R. 194

C

Cities Service Oil Co. 136
Clark Controller Co. 40
Cleveland Crane and Engineering Co. 48
Cleveland Quarries Co. 172
Cleveland Worm and Gear Co. ..... Cover 3
Columbia Electric Manufacturing Co. 194
Continental Foundry and Machine Co. 7
Crane Co. 149
Cunningham Co., M. E. 168
Cutler-Hammer, Inc. ..... Cover 2

D

Diamond Power Specialty Corp. 138
Documentation & Licenses, Paris, France 52
Dowell, Inc. 130
Dravo Corp. 200

E

Electric Controller and Manufacturing Co. 9, 165, 179
Electric Furnace Co., The 150
Electric Service Manufacturing Co. 151
Elliott Co. 44, 143

F

Falcon Bronze Co. 194
Farrel-Birmingham Co., Inc. 34
Flinn & Dreffein Engineering Co. 52
Foote Brothers Gear and Machine Corp. 175

G

General Electric Co. ..... Cover 4
Goodman Manufacturing Co. 182
Gulf Oil Corp. 10

H

Hagan Corp. 161, 169
Hallden Machine Co., The 52
Harnischfeger Corp. 173
Heil Process Equipment Corp. 186
Hyatt Bearings Division, General Motors Corp. 117
Hyde Park Foundry and Machine Co. 166

I

Ideal Industries, Inc. 144
Industrial Gear Manufacturing Co. 166
Iron and Steel Exposition 177

J

Johns-Manville Corp. 51
Joy Manufacturing Co. 50

K

Kaiser Aluminum & Chemical Sales, Inc., Chemical Division 46
Koppers Co., Inc. 32

L

Leeds and Northrup Co. 33
Lewis Foundry and Machine Division, Blaw-Knox Co. 41, 139

L

Link-Belt Co. 152
Lintern Corp. 160

M

Mackintosh-Hemphill Co. 163
Manning, Maxwell and Moore, Inc., Shaw-Box Crane and Hoist Division 197
Marvel Engineering Co. 47
Mathews Conveyor Co. 137
Medart Co. 176
Mesta Machine Co. ..... Cover 1
Metal & Thermit Corp. 192
John Miles & Partner (London, Ltd.) 52
Minneapolis-Honeywell Regulator Co., Industrial Division 14, 15
Morgan Construction Co. 42
Morgan Engineering Co. 170

N

National Bearings Division, American Brake Shoe Co. 39
National Carbon Co., A Division of Union Carbide and Carbon Corp. 36, 154
National Roll & Foundry Co. 2
Northern Engineering Works 29

O

Oakite Products, Inc. 164
Ohio Steel Foundry Co. 134
Okonite Co., The 28

P

Pennsylvania Transformer Co. 125
Pittsburgh Lectromelt Furnace Corp. 54
Pittsburgh Rolls Division, Blaw-Knox Co. 142
Poole Foundry and Machine Co. 20
Post-Glover Electric Co. 141

R

Ready-Power Co., The 140
Republic Flow Meters 153
Revere Electric Manufacturing Co. 164
Rockbestos Products Corp. 8
Ross Carrier Co., The 147
Rust Furnace Co. 115
Rust-Oleum Corp. 35

S

Salem-Brosius, Inc. 37
Selas Corp. of America 23
SKF Industries, Inc. 43
Smeeth-Harwood Co. 162
Square D Co. 146
Standard Carbon Co. 162
Stearns Magnetic, Inc. 188
Surface Combustion Corp. 16, 17

T

Taylor Chain Co., S. G. 174
Taylor Sons Co., Chas. 157
Texas Co., The 3
Tide Water Associated Oil Co. 31
Timken Roller Bearing Co., The 27
Tool Steel Gear and Pinion Co. 119
Torrington Manufacturing Co., The 178
Truflo Fan Co. 190

U

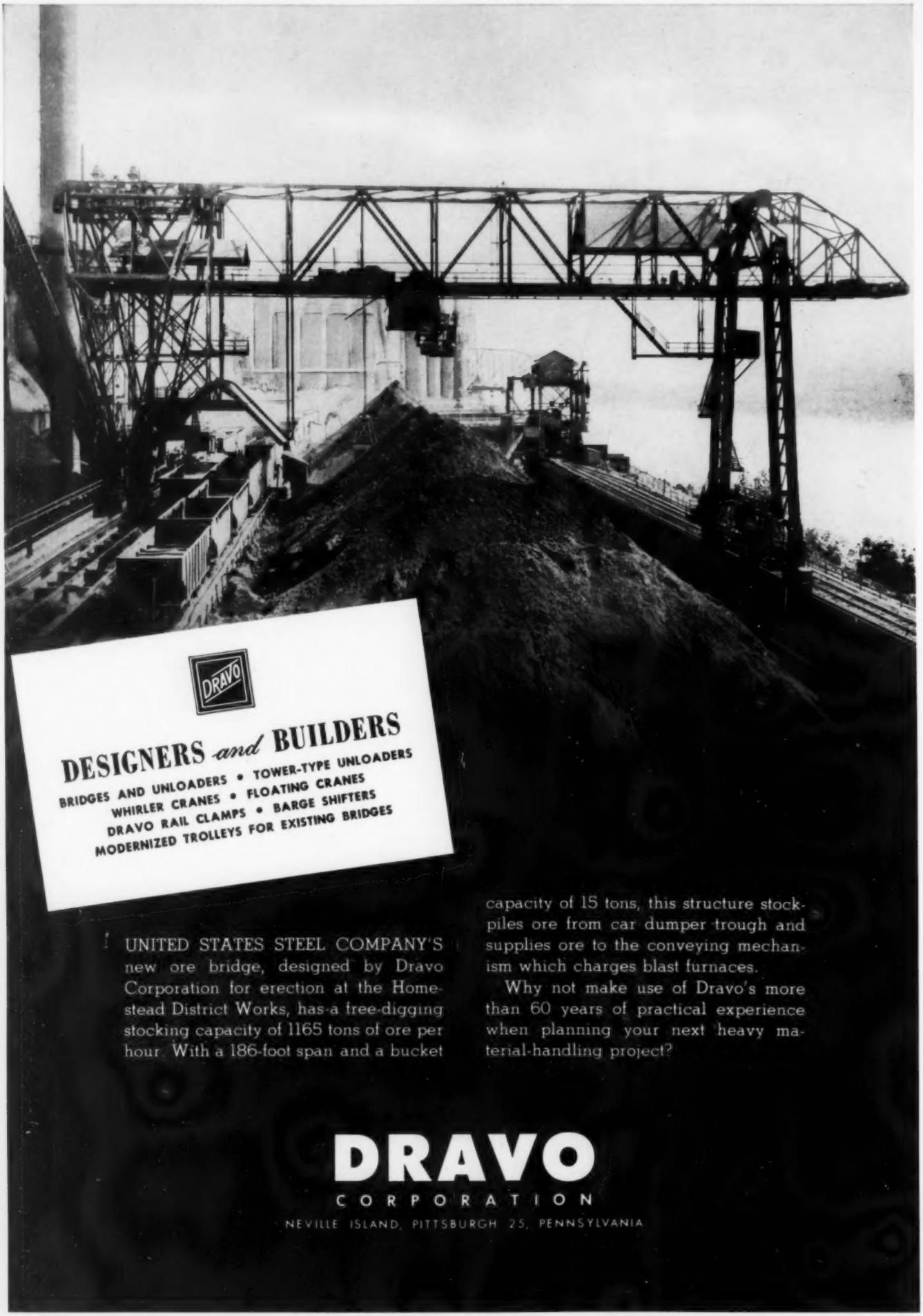
Union Carbide and Carbon Corp., National Carbon Co. 36, 154
Union Steel Castings Division, Blaw-Knox Co. 21
United Engineering and Foundry Co. 19
United States Graphite Co. 11

W

Wagner Electric Corp. 133
Waldron Corp., John 180
Watson Construction Co., Grant 126
Wean Engineering Co., Inc., The 52
Wean Engineering Co. of Canada, Ltd., The 52
Wean Equipment Corp. 52
Westinghouse Electric Corp. 18, 24, 25, 128, 129
Wilson Engineering Co., Inc., Lee 6, 123

Y

Youngstown Alloy Casting Corp. 30
Youngstown Foundry and Machine Co. 26
Youngstown Welding and Engineering Co. 38



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Why not make use of Dravo's more than 60 years of practical experience when planning your next heavy material-handling project?

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WORM GEARING—universal in its application—affords advantages for almost every power transmission job. Select worm-gear units to meet your need—small or large—from the complete line of Cleveland Worm Gear Speed Reducers. For detailed information, diagrams and rating tables on standard small Clevelands now available, write for our Bulletin 114.

Photo by courtesy of Continental Foundry & Machine Company.

CLEVELAND drive gives continuous performance

SLAB shears, working round the clock today, must have dependable drives. That's the reason so many of them—as with the Continental downcut shear and gauge shown here—are equipped with Clevelands.

In the production and fabrication of steel, Cleveland Worm Gear Speed Reducers and Worm Gearing operate a wide variety of equipment—from car dumpers and ore bridges right through the mills to heat-treat furnaces, finishing presses and loading-out cranes. In fact, wherever any industry needs a powerful, quiet, trouble-free right-angle drive, you're likely to find a Cleveland at work.

Wherever Clevelands serve—and you'll find tens of thousands of them on the job—many for 30 years and more—engineers will tell you that Clevelands will do their work under heavy loads, continuously or intermittently, no matter how severe the conditions, with a minimum of attention.

In or near your city, there's a Cleveland engineer ready to serve you. He will be glad to discuss your power transmission problems and suggest proper drives to meet your particular needs. The Cleveland Worm and Gear Co., 3278 East 80th Street, Cleveland 4, Ohio.

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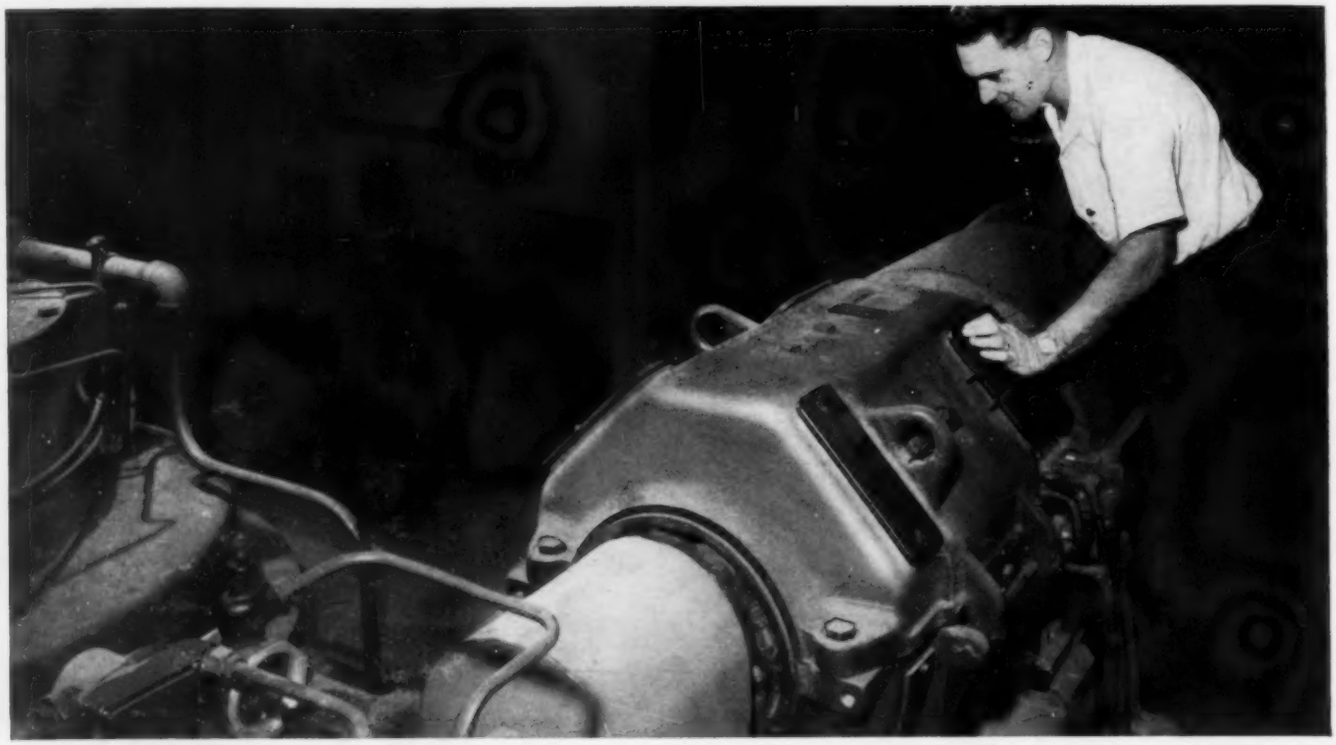


IN THE FONTANA, California plant of the Kaiser Steel Corporation the screwdown drives for the 86-inch hot strip mill comprise 8 G-E MD-600 75-hp totally enclosed mill motors (one shown). Basic motor frame is adaptable to other types of enclosures.

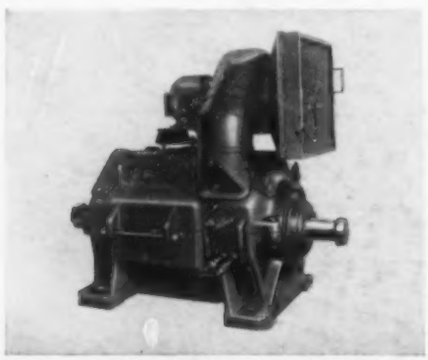
Alternate enclosures for basic motor save cost of extra motors

Conversion feature makes G-E mill motor adaptable to many steel-mill auxiliary jobs

Universal frame construction of General Electric MD-600 mill motors permits quick, easy adaptation of the basic motor to any one of four types: totally enclosed; totally enclosed with blower and filter; protected, self-ventilated; protected with blower. All you do is change the enclosure or blower. That cuts your changeover time, plus storage space and cost of extra standby motors!

What's more, rugged construction and improved insulation lengthen motor life, while many convenience features speed maintenance. Ask your G-E representative about G-E mill motors with G-E control, and send for Bulletin GEA-4654. *General Electric Co., Schenectady 5, N. Y.*

659-85



Totally enclosed with blower and filter (and totally enclosed, above)—Gasketed covers on all frame openings prevent entry of outside air.

Protected, self-ventilated—Hoods on top air discharge openings at drive end protect motor interior from falling objects.

Protected, with blower—Blower is driven by a Tri-Clad* motor, with both units mounted on bracket over the mill motor itself.

* *Registered trade-mark of General Electric Co.*

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